D2.2: Pedagogical approach and Course Syllabus

WP2, Task 2.2

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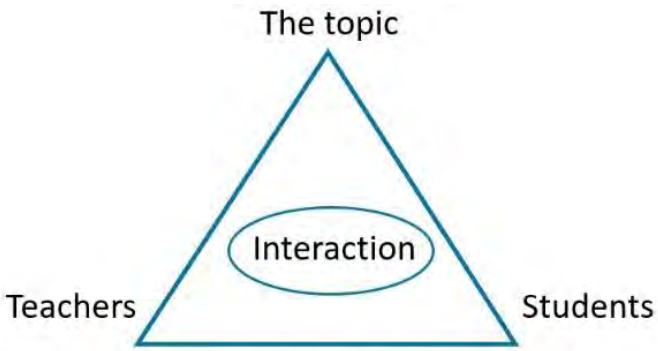
Foreword

Didactic choices for the nZEBRA course content, organization, and implementation

The topic nearly zero energy buildings have a high complexity, but it is also part of complex issues concerning society on individual level as well as societal level through the climate and sustainability aspects which form the basis for the needs for these buildings. Therefore, the course has its starting point in inclusive and society-based didactics as the overarching teachers' approach.

The didactic triangle, didactic agreement, and didactic relation

From a teacher's view – the didactics can be used to discern phenomena and reach deeper understanding about the topic, the social relations, and emotional factors within teaching which can lead to enhanced inclusion and diversity. The didactic triangle shows the relation within teaching which is constituted by an interplay between three entities, the student, the teacher, and the topic. The field within the triangle is the didactic activity space for creating interaction (Hopmann, 1997).



Example on a didactic triangle showing the interaction in teaching.

The didactic agreement is a social and often an implied one, and is simply put about agreeing on showing respect, to show calm attitudes and use a polite language for equal treatment which is a prerequisite for interaction. On a deeper level it includes everything that the student is expecting from the teacher and the teacher is expecting from the student i.e. the rules on what each participant in the didactic relationship must mutually manage (Delacour, 2016). Didactics' basic issues on teachings' what, how and why is related to the relation between teacher and student. A relational didactic is about developing stable social bonds, to meet the student here and now, but also to be cautious about how power is distributed in practice. With this perspective the democratic upbringing and to communicate knowledge are each other's prerequisites (Eek-Karlsson, 2022). Democracy and equal treatment are not just content to teach students for them to gain knowledge of. It is very much a question of learning through; by experiencing this both through the organization of the teaching and through the quality of the relationships. The student must have the opportunity to develop and understand the meaning of a democratic approach by being seen, respected and included. It is about seeing the students' experiences and diversity as an asset in teaching (Eek-Karlsson, 2022).

By creating and designing a course content for" blended learning" (on the web and on site) nZebra offers geographic inclusion and by this opportunity for greater diversity for those with limited possibilities to take part in lifelong learning through vocational training or higher studies on advanced level. In a "blended learning" concept where the direct interaction described above, only can occur

in a part of a course the student needs meaning making and understanding supported by a certain multimodality.
Teaching can then comprise reading texts, visit lecturing and repetition which from a multimodality perspective can view the meaning making as a form of design and re-design, where the one expressing is designing the content while the one interpreting the expression is re-designing the content. Online forum for interaction and networking between students provides further opportunities for re-designing and inclusion. To develop understanding for the topic the student needs to interpret various resources in interplay with others and combine them in his or hers specific way i.e. both designing and re-designing the topic content. The multimodal aspects are therefore central to the creation of meaning (Danielsson, 2022). This is the core and short description of the chosen didactics for the course content, organization, and implementation in nZebra. In the following chapters the pedagogically approaches, methods and learning objectives seen from the students' view are described and discussed.

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Abbreviations and acronyms

Table 1: Abbreviations and acronyms

Acronym	Description
GA	Grant Agreement
EU	European Union
LCA	Life Cycle Assessment
STEM	Science, technology, engineering, and mathematics

Executive summary

The nZEBRA project seeks to address the stringent regulations for nearly Zero Energy Buildings (nZEB) and the complexities involved in building behaviour through an intensive blended learning course.

Deliverable 2.2 outlines a comprehensive pedagogical framework, including a methodological framework, learning methods, and outcomes, and a course syllabus to educate students on Climate Neutral Buildings.

The primary objective of this deliverable is to design didactics, a pedagogical approach, and a course syllabus for the nZEBRA's modules to develop a flexible, student-centered, blended learning approach that is tailored to modern educational needs. This involves integrating both in-class and online learning methodologies to provide a comprehensive educational experience. The approach is designed to be adaptive, accommodating the diverse needs of the target group by utilizing field research methods, including design-thinking sessions, surveys, focus groups, and interviews. These efforts aim to identify specific core needs, challenges, and learning pathways that the course will efficiently address.

Another critical objective is to identify the educational needs and primary learning objectives necessary for upskilling and training students in the nZEBRA course. This includes understanding the requirements and preferences of the course participants and aligning the learning objectives accordingly. The deliverable defines general learning objectives and outcomes, alongside relevant didactic methods, assistive digital tools, and a balanced mix of in-class and online sessions. These components are shaped by the findings from the initial field research conducted at the international level.

The deliverable emphasizes the implementation of constructivist and collaborative learning models. The learning perspective of the nZEBRA project focuses on the student's understanding and knowledge through experiences, reflection, and collaboration. Additionally, the learning strategies involve group work to enhance student interaction and shared insights, fostering a deeper understanding of climate-neutral buildings and related topics. The didactic and pedagogical approaches are essential for engaging students actively in the learning process.

In this deliverable, we also present an experiential and hands-on learning approach as another key aspect of the pedagogical framework in the nZEBRA project. Experiential learning emphasizes learning-by-doing, providing students with practical, real-world experiences that enhance their understanding of sustainable building practices. Besides, hands-on learning, particularly in Science, Technology, Engineering, and mathematics (STEM) subjects, involves direct manipulation of materials and objects to acquire skills and knowledge. We consider this approach for some modules to give students tangible, practical experience that complements theoretical knowledge.

In D2.2, we also discuss the pedagogical and methodology framework, including mechanisms for continuous feedback and reflective practice. In the nZEBRA course, we delve into providing students with regular, constructive input on their performance, enabling them to adjust their learning strategies and improve their understanding continuously. Additionally, we consider reflective practice to encourage students to critically analyze the learning experiences, understand their learning processes, and identify areas for personal and professional growth.

In nZEBRA, we provide advanced learning tools and platforms that play a crucial role in supporting the pedagogical approach. In the nZEBRA project, we opted for the Blackboard platform, which has several merits compared with other platforms. We also employ multimedia and communication tools

to facilitate both synchronous and asynchronous learning activities. These tools will enable live discussions, interactive sessions, and a seamless integration of various learning activities within the nZEBRA course.

The deliverable 2.2 is structured as follows:

- The chapter introduces this deliverable, including its purpose, scope, audience, and partners' contributions.
- Chapter 2 describes the methodological framework and pedagogical approach in nZEBRA.
- Chapter 3 summarizes the course format in nZEBRA including in-class and online training.
- Chapter 4 expresses the deductive learning objectives and outcomes in nZEBRA.
- Chapter 5 explains constructive alignment and the pedagogical approach implementation.
- Chapter 6 explains the learning tools, multimedia, and communication platforms.
- Chapter 7 summarizes the main outcomes of deliverable 2.2.

Keywords

Didactics and pedagogical approach, Syllabus, Methodological framework, Learning methods

1.Introduction

1.1. Purpose, scope and audience

According to the Description of Action, task 2.2 contributes to creating a flexible, student-centred blended learning approach adapted to modern educational patterns. The main aim of this task is to understand the educational needs for upskilling and training by identifying the primary learning objectives alongside student requirements for the nZEBRA course. Additionally, the objectives of Task 2.2 related to the entire WP2 include:

1. Adapting the target group's needs analysis to current and emerging trends and demands using field research methods, including design-thinking sessions, surveys, focus groups, and interviews. These efforts will define specific core needs, challenges, and learning pathways that the project course will efficiently address.
2. Defining the general learning objectives and outcomes of the course, along with relevant didactics, assistive digital tools, educational formats, and the balance between in-class and online sessions. The findings from the field research will be incorporated here. The remaining objectives of WP3 will be addressed in subsequent tasks of WP3. This deliverable outlines the results of the field research conducted during the initial months of the nZEBRA project at the EU level.

1.2. Partners' contributions

The following Table 2 lists the main contributions of project partners in this deliverable.

Table 2: Contribution of partners

Beneficiary name	Contribution
ALBERT-LUDWIGS-UNIVERSITAET FREIBURG (E10208635 - DE)	UFR lead task 2.2 and prepare the dedicated deliverable (D2.2).
HOGSKOLAN I HALMSTAD (E10200676 - SE)	Foreword and review the document
TECHNISCHE UNIVERSITAT HAMBURG (E10208607 - DE)	Review the document
LUNDS UNIVERSITET (E10209141 - SE)	Review the document
HEP - ESCO DOO ZA VODENJE I	Review the document

1.3. Relation to other activities in the project

Table 3 below lists how this deliverable relates to other activities in task 2.2 in the project, and which should be considered for further understanding.

Table 3: Relation to other activities in the project

Related WP / task / deliverable	Relation
WP3/Task 2.2/Deliverable 2.2	Definition of course syllabus and pedagogical approach, blended format, learning pre-requisites and learning outcomes.

2. Methodological Framework and Pedagogical Approach in nZEBRA

2.1. Constructivist Learning

Constructivism, an important learning theory that educators use to help their students learn, will be particularly beneficial for the nZEBRA project. Constructivism is based on the idea that people actively construct or make their own knowledge, and that reality is determined by their experiences as learners. Essentially, learners use their previous knowledge as a foundation and build on it with new things they learn, making their learning unique to them based on individual experiences.

Understanding constructivism is crucial for educators because it influences how all students learn. Teachers and instructors who understand constructivist learning theory recognize that students bring their own unique experiences to the classroom every day. Their background and previous knowledge impact how they can learn. Educators can use constructivist learning theory to help students connect new knowledge with their previous experiences, enhancing their understanding.

In the nZEBRA course, applying constructivist principles will enable instructors to tailor the learning experience to individual students' needs and backgrounds. This approach ensures that each student can build on their existing knowledge and experiences, leading to a deeper and more personalized understanding of climate neutral buildings and related topics. By integrating constructivism into the course design, nZEBRA will provide a more effective and engaging educational experience for all participants.

2.1.1. Types of constructivism

There are different types of constructivism that educators can use to find success with this learning theory.

Cognitive: Cognitive constructivism operates on the perception that students actively construct knowledge based on their present stage of cognitive development. Students make sense of new knowledge by weaving it into their understanding of the world and their experiences up to that moment.

Social: Social constructivism emphasizes interactions with others as a basis for learning. People glean knowledge from individual relationships, their culture, and their environment, as well as their role within larger communities. In essence, social constructivism operates on the belief that "it takes a village to raise a child" and that students' interactions with others help them construct their knowledge to build upon further.

Radical: Radical constructivism views knowledge as something a student creates based on their own experiences and not handed from teacher to student. Radical constructivism encompasses the philosophy that knowledge is subjective and that every student constructs their knowledge based on personal perspective. As a result, radical constructivism calls for teachers to offer students more opportunities to create their knowledge and be aware of their students' different perspectives and backgrounds, which informs each student's learning process. (University N. , 2024)

2.1.2. Constructivism in education

It's important to understand how teachers can apply constructivism inside their classroom to create a unique learning environment for students. In constructivist classrooms, the teacher has a role to create a collaborative environment where students are actively involved in their own learning. Teachers are more facilitators of learning than actual instructors. Teachers must work to understand the preexisting conceptions and understanding of students, then work to incorporate knowledge within those areas. Teachers will also need to adjust their teaching to match the learner's level of understanding.

Constructivist classrooms rely on four key areas to be successful:

- Shared knowledge between teachers and students.
- Shared authority between teachers and students.
- Teachers act as a guide or facilitator.
- Learning groups consist of small numbers of students.

Constructivist classrooms are often very different from normal classrooms in many ways. Constructivist classrooms focus on student questions and interests, they build on what students already know, they focus on interactive learning and are student-centered, teachers have a dialogue with students to help them construct their own knowledge, they root in negotiation, and students work primarily in groups.

Constructivist classrooms often have teachers who do small group work, collaborative and interactive activities, and open dialogues about what students need to find success. (wgu, 2020)

2.1.3. Disadvantages of constructivist methods

- **Preparation and Adjustment Time**: Constructivist strategies require significant preparation time for teachers and a prolonged adjustment period for students.
- **Assessment Challenges**: Teachers find it difficult to assess if students have reached correct conclusions, despite students being active and following instructions.
- **Prior Knowledge Variability**: Differences in students' prior knowledge can hinder individual and group learning processes, necessitating extra support.
- **Increased Assessment Needs**: More varied assessment strategies are required to gauge student progress accurately, as conclusions are student-drawn.
- **Development and Subject Compatibility**: Constructivist methods need to be tailored to students' developmental levels (as per Piaget) and may not align well with certain subjects or standardized curricula, requiring a different grading system. (Info, 2024)

2.2. Blended Learning

Blended learning (**: Blended learning structure** Figure 1), a pedagogical approach that integrates face-to-face learning and e-learning (online learning) into a single, cohesive instructional strategy, will be particularly beneficial for the nZEBRA project. This combination is designed to capitalize on the benefits of both modalities while mitigating their respective drawbacks, ultimately aiming to provide a comprehensive and flexible educational experience tailored to the project's goals. By using blended learning, nZEBRA can effectively deliver its intensive course on climate neutral buildings, ensuring that both the theoretical and practical aspects of the subject are thoroughly covered.

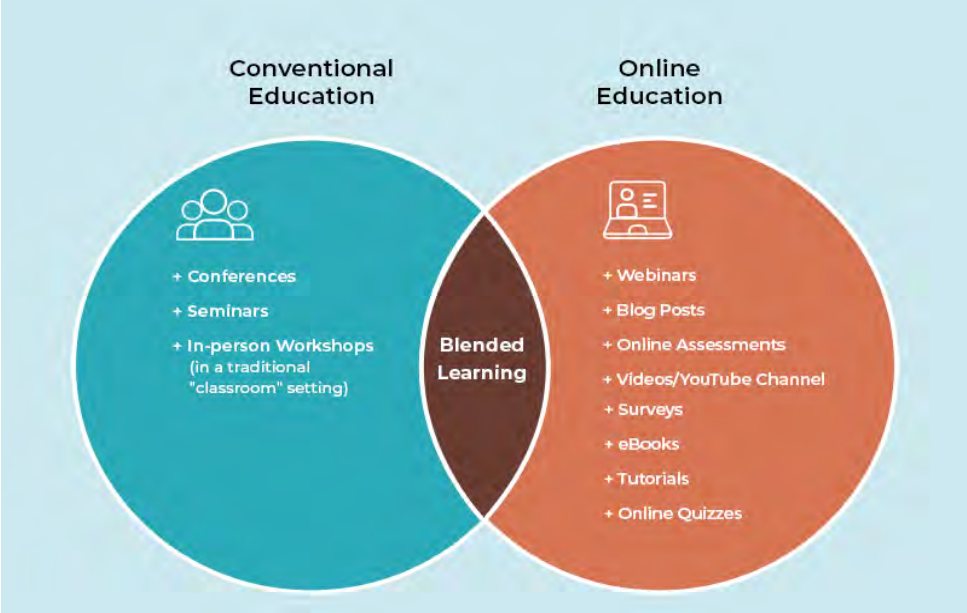

Figure 1 : Blended learning structure *(Sharma, 2017)*

2.2.1. Blended Learning Models

Flipped Model: In the flipped model, the traditional approach to classroom instruction is reversed. Students first engage with the instructional content outside of class, typically via video lectures, readings, or online modules. Classroom time is then dedicated to active learning activities such as discussions, group projects, and exercises that help reinforce and apply the material learned beforehand. This model allows for more personalized and interactive learning during face-to-face sessions, providing students with the flexibility to learn at their own pace.

Face-to-Face Driver Model: The face-to-face driver model closely resembles traditional classroom training, with most of the instruction occurring in a classroom setting under the guidance of an instructor. This approach provides individual, personalized support to learners who may be struggling to grasp new concepts or who are falling behind in the curriculum.

Rotational Model: In the rotational model, learners cycle through different learning modalities such as face-to-face instruction, online activities, small-group discussions, and independent study. These rotations can follow a fixed schedule (e.g., daily or weekly) or be based on the learners' progress. This model offers flexibility and accommodates various learning styles, allowing learners to work in the modality that best suits their needs at a particular time.

Flex Model: The flex model grants learners significant autonomy and control over their learning paths. It combines online learning with in-person support as needed. Utilizing an adaptive learning platform, learners have the flexibility to choose when and where they access online content and resources, making it ideal for self-paced learning. Instructors are available to aid as required, helping learners navigate through the material and address any challenges.

Enriched Virtual Model: The enriched virtual model primarily involves online learning with occasional face-to-face sessions. Most of the learning takes place in a virtual environment, but learners attend physical classes or workshops at scheduled times for hands-on activities, assessments, or collaborative projects. This model combines the flexibility of online learning with the benefits of in-person interaction, ensuring learners receive both individualized instruction and opportunities for group engagement. (Gupta, 2024)

2.2.2. Key Characteristics of Blended Learning

Face-to-Face Learning: This method involves direct, in-person interaction between learners and teachers or trainers. It usually happens in a group setting, which allows for real-time communication, immediate feedback, and hands-on activities. The teacher often guides discussions and facilitates group work, though they do not always have to control the entire learning process.

E-Learning (Online Learning): This method uses electronic or digital media to support learning. It lets learners access educational content and resources remotely, at their own pace, and often on their own. E-learning can include multimedia resources, interactive simulations, virtual classrooms, quizzes, and discussion forums. It can support both individual and collaborative learning experiences.

Flexibility and Accessibility: Blended learning offers the flexibility of e-learning, enabling students to access materials and complete assignments from any location with internet access. This flexibility is particularly beneficial for learners with varying schedules and those who need to balance education with other commitments.

At the same time, it retains the personal interaction and immediate support provided by face-to-face learning, which can enhance understanding and retention through direct engagement and hands-on activities.

Personalized Learning Experience: By combining these two methods, blended learning can be tailored to meet the diverse needs of individual learners. Teachers can use online tools to track progress and customize instruction, while in-person sessions can be used to address specific challenges, provide additional support, and foster deeper engagement.

Optimized Learning Outcomes: The integration of face-to-face and e-learning aims to achieve the "best of both worlds." Face-to-face learning facilitates social interaction, immediate feedback, and hands-on experiences, which are crucial for certain types of learning. E-learning offers flexibility, accessibility, and the ability to use diverse multimedia resources, which can enhance engagement and understanding.

Balanced Approach: Blended learning seeks to balance the high level of teacher control found in face-to-face settings with the self-paced, autonomous nature of e-learning. This balance helps address the disadvantages of each method: the potential for limited individual focus in group-based face-to-face learning and the isolation and potential lack of immediate support in e-learning.

2.3. Collaborative Learning

Collaborative learning is an educational strategy that involves groups working together to improve the teaching and learning experience. This approach will be particularly beneficial for the nZEBRA project, as it usually involves groups of at least two learners collaborating to grasp new concepts, solve problems, or complete tasks. Group work encourages learners to engage more actively in processing, understanding, and applying the presented concepts or information, rather than merely memorizing facts or numbers. By incorporating collaborative learning into the nZEBRA course, participants can benefit from enhanced interaction and shared insights, leading to a deeper understanding of climate neutral buildings and related topics.

2.3.1. Collaborative learning Models

Group-problem solving: Like case studies, group-problem solving activities force the team to come up with a solution to a given problem. In these activities, team members must communicate with each other, providing rationales for the solutions they propose as well as feedback to their team members in case there is conflict in the approaches put forward.

Jigsaw technique: Jigsaw technique forces each member of the unit to deepen their understanding in one area and then share their knowledge with the rest of the team one by one. In corporate settings, the logic is that it makes it easier for students who specialize in a specific role or function to easily retain important information while also opening possibilities for cross-training within the team.

Cooperative learning: Cooperative learning is a method of instruction seen in classrooms in which two or more students work together to achieve outcomes that are beneficial to them on an individual level as they are to the team as a unit. For example, one team member works on a task that helps them achieve a personal goal associated with a project, which they then share with the rest of the team so that they gain additional insight to further their progress and vice versa.

Daily discussion questions: A daily discussion question is any question posed every day to a group of two or more people that sparks the sharing of ideas or opinions. Often used in classroom settings to get students engaged, daily discussions have since made their way to corporate settings to lighten the mood among team members and get them engaged in meaningful discussions. Daily discussions can range from work-related topics to everyday situations that spark some controversy. (Kaltura, 2023)

Peer reviews: Peer reviews are the future of performance evaluations. They enable two-way learning, letting students view and be inspired by one another's work. Students learn a lot by getting feedback from people other than their manager. Plus, by giving feedback, students can put themselves in a coaching role, which compels them to think critically about how to explain and approach the work they do. (Learning, 2023)

2.3.2. Key Characteristics of Collaborative Learning

- Collaborative learning approaches have a positive impact, on average, and may be a cost-effective approach for raising attainment.
- Students need support and practice to work together; it does not happen automatically. Professional development can support the effective management of collaborative learning activities.
- Tasks and activities need to be designed carefully so that working together is effective and efficient, otherwise some students may struggle to participate or try to work on their own. It

is important to ensure that all students talk and articulate their thinking in collaborative tasks to ensure they benefit fully.
- Competition between groups can be used to support students in working together more effectively. However, overemphasis on competition can cause learners to focus on winning rather than succeeding in their learning.
- The most promising collaborative learning approaches tend to have group sizes between 3 and 5 students and have a shared outcome or goal. (Foundation, 2024)

2.4. Experiential and Hands-on Learning

2.4.1. Experiential Learning

Experiential learning, a process through which learners develop knowledge, skills, and values from direct experiences outside a traditional academic setting, will be particularly beneficial for the nZEBRA project. Grounded in the idea that individuals learn best through experience and reflection on those experiences, this method emphasizes learning by doing, where students engage in activities that require critical thinking, problem-solving, and decision-making. By incorporating experiential learning, the nZEBRA course can provide participants with practical, real-world experiences that enhance their understanding of climate neutral buildings and related topics.

2.4.2. Hands-on Learning

Hands-on learning, a type of experiential learning where learners are actively involved in a learning activity rather than passively receiving information, will also be advantageous for the nZEBRA project. This approach involves physical participation and direct manipulation of materials or objects to understand concepts and acquire skills. Emphasizing practical experience, hands-on learning is often used in subjects like science, technology, engineering, and mathematics (STEM). By integrating hands-on learning into the nZEBRA course, participants can gain practical, tangible experience in sustainable building practices, further enhancing their learning and skill development.

2.4.3. Kolb's (1984) cycle

Kolb's (1984) cycle of learning depicts the experiential learning process (Figure *2*). This process includes the integration of:

Concrete Experience:

- **Description**: Engaging directly in an authentic situation or activity.
- **Example**: A student participates in a science experiment or a business simulation game.
- **Purpose**: To provide the learner with a new experience or re-engage in an existing experience to gain fresh insights.

Reflective Observation:

- **Description**: Observing and reflecting on the experience, noticing what happened, and relating it to past experiences and conceptual understandings.
- **Example**: After the science experiment, the student reflects on the procedures, results, and their feelings during the process.
- **Purpose**: To help the learner make sense of the experience by identifying patterns and inconsistencies, and considering what was learned.

Abstract Conceptualization:

- **Description**: Distilling perceptions into abstract concepts and generalizations.
- **Example**: The student develops theories or models based on their reflections, such as understanding why certain chemical reactions occur.
- **Purpose**: To help the learner create theories or models that can be tested in future situations, forming a basis for understanding broader principles.

Active Experimentation:

- **Description**: Testing new ideas and honing skills in a new experience, applying what was learned to see if it holds true.
- **Example**: The student designs and conducts a new experiment to test their theories or applies the new knowledge to a different context.
- **Purpose**: To implement the abstract concepts and see how they work in practice, leading to new concrete experiences and continuing the cycle.

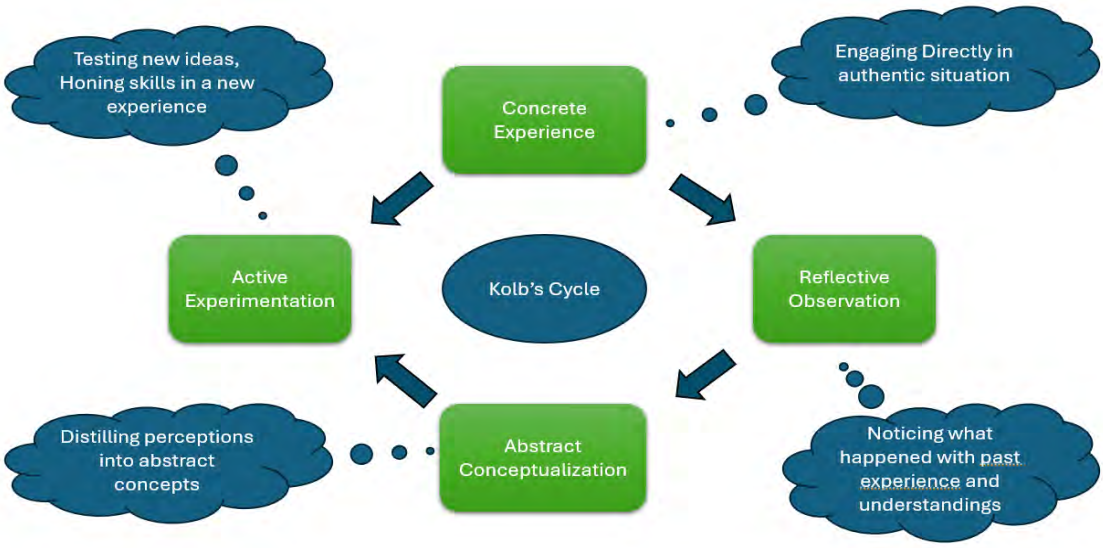

Figure 2: Kolb's Cycle *(University B. , 2024)*

2.5. Student-Centered Learning

Student-centered learning, an educational approach that focuses on the needs, interests, and abilities of students, will be particularly beneficial for the nZEBRA project. This method emphasizes active learning, critical thinking, and personalized education, where students have significant control over what they learn, how they learn it, and how they demonstrate their knowledge. In a student-centered learning environment, the teacher acts as a facilitator or guide, helping students take responsibility for their own learning and encouraging them to engage deeply with the material. By adopting a student-centered learning approach, the nZEBRA course can effectively cater to the individual learning preferences of participants, fostering a more engaging and effective educational experience in the field of climate neutral buildings.

2.5.1. The main principles of student–centered learning as

- The learner has full responsibility for her/his learning
- Involvement and participation are necessary for learning
- The relationship between learners is more equal, promoting growth, development
- The teacher becomes a facilitator and resource person
- The learner experiences confluence in his education (affective and cognitive domains flow together)
- The learner sees himself differently because of the learning experience (STUDENT–CENTRED LEARNING, 2005)

2.5.2. Implement student–centered learning

Learning is often presented in this dualism of either student-centered learning or teacher-centered learning. In the reality of practice, the situation is less black-and-white. A more useful presentation of student-centered learning is to see these terms as part of a continuum, using the three concepts regularly used to describe student-centered learning, see Figure *3*.

Teacher-Centered Learning	Student-Centered Learning
Low level of student choice	High level of student choice
Student passive	Student active
Power is primarily with teacher	Power primarily with student

Figure 3: Student Centred Learning *(STUDENT–CENTRED LEARNING, 2005)*

When examining how to apply this in practice, it is worth considering how far up the continuum one can move within the contextual barriers of the teaching situation. The next sections will present some ideas for practice to aid in making that progression.

2.5.3. Implications for assessment practices

Table *4* outlines various student-centered learning activities divided into those conducted outside the lecture format and those within it. Outside the lecture, activities include independent projects, group discussions, peer mentoring, debates, field trips, practical's, reflective diaries, computer-assisted learning, and portfolio development.

Table 4 : Examples of student-centered learning/teaching methods *(STUDENT–CENTRED LEARNING, 2005)*

Outside of the Lecture Format	In the Lecture
Independent projects	Buzz groups (short discussion in twos)
Group discussion	Pyramids/snowballing (Buzz groups continuing the discussion into larger groups)
Peer mentoring of other students	Crossovers (mixing students into groups by letter/number allocations)
Debates	Rounds (giving turns to individual students to talk)
Fieldtrips	Quizzes
Practical	Writing reflections on learning (3/4 minutes)

Reflective diaries, learning journals	Student class presentations
Computer assisted learning	Role play
Choice in subjects for study/projects	Poster presentations
Writing newspaper article	Students producing mind maps in class
Portfolio development	

These activities encourage deeper engagement, collaboration, practical application of knowledge, and personal reflection. In contrast, within the lecture setting, activities such as buzz groups, pyramids/snowballing, crossovers, rounds, quizzes, reflective writing, student presentations, role play, poster presentations, and mind mapping foster interactive and participatory learning. These methods aim to enhance student involvement, critical thinking, and understanding by integrating both individual and collaborative approaches.

Involving students at the stage when the task is set:

- Choosing the assessment task
- Setting the assessment task
- Discussion the assessment criteria
- Setting the assessment criteria (STUDENT–CENTRED LEARNING, 2005)

Involving students at the stage after the task is completed:

- Making self-assessment comments
- Making peer-assessment feedback comments
- Suggesting grades/marks - self-assessment
- Negotiating grades/marks - self-assessment
- Assigning grades/marks - self-assessment
- Assigning grades/marks - peer-assessment (STUDENT–CENTRED LEARNING, 2005)

2.5.4. Key Characteristics of Student-Centered Learning

Active Learning: Students engage actively in the learning process through discussions, problem-solving, case studies, role plays, and other interactive activities. Encourages deeper understanding and retention of knowledge by involving students directly in their own learning.

Personalized Learning: Instruction is tailored to the individual needs, interests, and abilities of each student. Addresses diverse learning styles and paces, allowing students to learn in ways that are most effective for them.

Student Autonomy and Responsibility: Students have significant control over their learning experiences, including choice in topics, learning methods, and types of assessments. Promotes self-motivation, accountability, and a sense of ownership over their learning journey.

Collaborative Learning: Learning often occurs in groups, where students work together to solve problems, complete projects, and discuss concepts. Develops teamwork, communication skills, and the ability to view problems from multiple perspectives.

Inquiry-Based Learning: Students learn by asking questions, conducting research, and exploring topics in depth. Fosters curiosity, critical thinking, and independent research skills.

Reflective Learning: Reflection is a key component, where students think critically about their learning experiences, understand their own learning processes, and make connections to prior knowledge. Enhances self-awareness and helps students develop the ability to evaluate and improve their learning strategies.

Teacher as Facilitator: The role of the teacher shifts from being the primary source of information to being a guide or coach who supports and facilitates student learning. Encourages students to take an active role in their education and develop independent learning skills.

Assessment for Learning: Ongoing assessments are used to provide feedback, guide learning, and adjust instruction to meet student needs. Focuses on growth and improvement rather than just measuring performance, supporting continuous learning.

2.6. Continuous Feedback and Reflective Practice

Continuous feedback, a pedagogical approach where students receive regular, constructive input about their performance, will be particularly beneficial for students in the nZEBRA project. This feedback can be delivered through various means, including verbal comments, written notes, digital platforms, and peer assessments. The essence of continuous feedback lies in its frequency and immediacy, ensuring that students receive timely insights that help them understand their progress and areas needing improvement. By incorporating continuous feedback into the nZEBRA course, students can benefit from regular, actionable insights, allowing them to adjust their learning strategies and improve their understanding of climate neutral buildings. This ongoing support helps students stay on track, enhances their learning experience, and ensures they achieve the desired educational outcomes effectively.

2.6.1. Types of Continuous Feedback

Formative Feedback:

- Given during the learning process to help students improve before final assessments.
- Examples: Comments on drafts, feedback during practice sessions, quizzes with immediate feedback.

Summative Feedback:

- Provided after a final assessment to summarize overall performance.
- Examples: Final grades with comments, end-of-term evaluations.

Peer Feedback:

- Feedback provided by classmates or group members.
- Examples: Peer reviews of assignments, group project feedback sessions.

Self-Feedback:

- Students assess their own work and progress.
- Examples: Self-assessment checklists, reflective journals.

2.6.2. Importance in Learning

Timely Corrections: Immediate feedback helps students correct mistakes and misunderstandings early, preventing the reinforcement of incorrect knowledge or skills.

Increased Engagement: Regular feedback keeps students engaged and motivated, as they can see tangible progress and understand how to improve continuously.

Personalized Learning: Continuous feedback provides tailored insights that cater to individual learning needs, addressing specific strengths and areas for improvement.

Confidence Building: Positive feedback boosts students' confidence, while constructive feedback helps them develop resilience and a growth mindset, viewing challenges as opportunities for improvement.

Better Learning Outcomes: Frequent feedback loops help students achieve better learning outcomes by continually refining their understanding and skills based on the guidance received.

2.6.3. Reflective Practice

Reflective practice, which involves critically thinking about one's experiences, actions, and decisions to learn and improve continuously, will be particularly beneficial for students in the nZEBRA project. This approach encourages learners to analyze their experiences, understand their learning processes, and identify areas for personal and professional growth. Reflective practice can be facilitated through activities such as journaling, discussions, and self-assessment exercises. By integrating reflective practice into the nZEBRA course, students can develop a deeper understanding of climate neutral buildings and related topics. This continuous self-evaluation helps students identify strengths and areas needing improvement, fostering personal and professional growth and enhancing their overall learning experience.

2.6.4. Types of Reflective Practice

Reflective Journals

- Students regularly write about their learning experiences, challenges, and insights.
- Example: Daily or weekly journal entries reflecting on lessons learned and personal growth.

Group Discussions

- Reflective discussions with peers or instructors to share experiences and insights.
- Example: Reflection circles or group debriefs after a project or lesson.

Self-Assessment

- Students evaluate their own work and learning progress.
- Example: Self-assessment rubrics, goal setting and reflection exercises.

Mentorship and Coaching

- Reflective sessions with a mentor or coach to discuss experiences and receive guidance.
- Example: Regular meetings with a mentor to reflect on academic or professional growth.

2.6.5. Importance in Learning

Deepened Understanding: Reflective practice helps students develop a deeper understanding of concepts by connecting theoretical knowledge with personal experiences.

Enhanced Critical Thinking: By reflecting on their actions and outcomes, students improve their critical thinking and problem-solving skills, learning to evaluate and adjust their approaches.

Self-Awareness: Reflection fosters self-awareness, helping students recognize their strengths, weaknesses, and learning styles, which can guide their future learning strategies.

Lifelong Learning: Encourages the habit of lifelong learning, as students become more adept at self-assessment and self-improvement, skills that are valuable beyond the classroom.

Improved Academic Performance: Regular reflection can lead to improved academic performance as students identify and address gaps in their understanding and approach.

2.6.6. Integrating Continuous Feedback and Reflective Practice

Holistic Learning Environment: Combining continuous feedback with reflective practice creates a holistic learning environment where students are actively involved in their learning journey. They receive regular guidance and support, enabling them to make informed decisions and improvements. Simultaneously, they engage in self-reflection, developing a deeper, more personal understanding of the material and their learning processes.

Collaborative and Supportive Learning: This approach promotes a collaborative and supportive learning environment. Teachers and peers provide feedback, while students contribute to their own learning through reflection, creating a dynamic and interactive educational experience.

Sustained Growth and Improvement: Together, continuous feedback and reflective practice foster sustained growth and improvement. Students learn to value feedback as a tool for development and view reflection to continuously evolve, leading to a more engaged, motivated, and successful learning experience. This combination helps build a foundation for lifelong learning, equipping students with the skills needed to adapt and thrive in various personal and professional contexts.

2.7. Prerequisites

The nZEBRA's course requires several prerequisites including basic knowledge on energy building, energy systems, Energy Performance in Buildings Directive (EPBD), climate change, circular economy, recycling, life cycle assessment.

Prerequisites for Life Cycle Assessment (LCA) of buildings (TUHH):

Students need to have a basic understanding of construction processes to be able to understand and follow the LCA modeling in the construction sector. They should also have a basic knowledge in Environmental topics like sustainability, or environmental impacts to be able to interpret the results of LCA assessment.

2.8. nZEBRA Methodological Framework

Table 5 : Methodological Framework

Topics	Leader	Weeks & Order	ECTs	Learning objectives	Examination	Pedagogical approach	Learning tools	Course Syllabus
Climate change adoptation	ULUND	**A**		See chapter 4	Assignments& written examination	Blended Learning	To be defined later	See chapter 4
Circular economy in the construction	HH	B	1	See chapter 4	Assignments& written examination	Blended Learning	Reading, discussions and writing assignments	See chapter 4
Life Cycle Assessment	TUHH	C	1	See chapter 4	Project work & Final presentation	CBL	OpenLCA tool	See chapter 4
Energy production/supply in buildings	UFR	D 3-5	1	See chapter 4	final exam & assignments	Blended Learning	Energy+, PVsyst	See chapter 4
Smart buildings	HEP ESCO	E 1-2	1	See chapter 4	assignments during the course plus part of final exam	Blended Learning	Energy Managemet tool	See chapter 4
Environmental Social Governance	HH	F	1	See chapter 4	Group/team work	Blended Learning	To be defined later	See chapter 4

3.Course Format in nZEBRA

3.1. In-class Training

Certain modules in the nZEBRA course will require interaction in a physical classroom to facilitate effective learning and engagement.

3.1.1. Interactive lectures

Interactive lectures will involve dynamic teaching sessions where students actively participate through discussions, questions, and interactive activities. Unlike traditional lectures, these sessions will focus on engaging students directly, encouraging critical thinking and immediate feedback. This approach helps deepen understanding of complex topics related to climate neutral buildings by fostering a collaborative learning environment. As an example, here we provide the detailed information on module format with topic of Smart Building (T3.5) as follows:

T 3.5. with the topic Smart Building

Total duration: 25 hours held in the course of 5 days (5 hours per day)

DAY 1.

Topics:

- Smart building concept, definition and significance
- Global overview and historical view
- Regulatory framework of EU
- Technological development and reflection on buildings
- Goals and benefits of smart building
- Example of EU funded project – 3 Smart (Smart building, smart network, smart city)

Duration: 5 hours

Method:

- Live Interactive lecture
- questionnaire for students on preliminary knowledge on “smartness” concept

DAY 4.

Topics:

- The basic principles of how new technologies and processes are used towards building smartness such as demand side management
- Human factor, systems maintenance and building use
- Evaluation of assignment from Day 2 and assignment for Day 5

Duration: 5 hours

Method:

- Live Interactive lecture
- Interactive evaluation of assignment

DAY 5.

- Examples in which a building incorporated various smart technologies and processes.
- Following evaluation of assignment from Day 4 – recommendations for instalment of specific new technologies which would make the building “smarter” (in order of priority and cost-benefit if possible)

Duration: 5 hours

Method:

- Live Interactive lecture
- Interactive evaluation of assignment

3.1.2. Workshops and seminars

Workshops and seminars will provide hands-on learning experiences and in-depth discussions on specific topics. Workshops will focus on practical applications, where students can engage in activities, simulations, and problem-solving exercises. Seminars will offer opportunities for detailed discussions, presentations, and group work, allowing students to delve deeper into the subject matter, share insights, and collaborate on project.

T 3.5. with the topic Smart Building

DAY 2.

Topics:

- Smart readiness indicators SRI
- Relevance of building type and climate for SRI
- Existing methodologies for SRI calculation
- Key functionalities and technological domains of SRI
- SRI - examples of buildings
- Assignment (challenge and project based): SRI calculation for a specific building (each student or small group evaluates one of 9 technological domains)

Duration: 5 hours

Method:

- Online or hybrid workshop
- assignment for students

DAY 3.

Topics:

- Smart metering and data collection – technologies and application

- International Performance Measurement and Verification Protocol (IPMVP)
- Indoor environmental quality
- Presentation of energy management tool

Duration: 5 hours

Method:

- Online or hybrid workshop

3.2. Online Training

The online training component of the nZEBRA course will leverage digital platforms to provide flexible and accessible learning experiences. This will include a mix of asynchronous and synchronous learning activities designed to complement in-class training.

Figure 4 compares three educational approaches: Online Collaborative Learning (OCL), Online Distance Education (ODE), and Online Courseware (OC).

- **OCL** emphasizes group learning, instructor-led activities, asynchronous participation, place independence, and text-based, internet-mediated discourse.
- **ODE** focuses on individual learning with tutor support, online delivery, text-based assignments, asynchronous learning, and internet-mediated delivery.
- **OC** provides online content and quizzes, individualized learning, computer assessment, asynchronous participation, place independence, video-based lectures, and internet-mediated presentations.

Each approach highlights different methods and tools to facilitate effective online education tailored to various learning preferences and environments.

Online Collaborative Learning (OCL)	Online Distance Education (ODE)	Online Courseware (OC)
Online discourse	Online delivery	Online content+quiz
Group learning	Individual learning	Individualized learning
Instructor led	Tutor support	Computer assessment
Asynchronous	Asynchronous	Asynchronous
Place independence	Place independence	Place independence
Text-based discussion	Text-based assignments	Video-based lectures
Internet-mediated discourse	Internet-mediated delivery	Internet-mediated presentation

Figure 4: Three Types of Online Learning *(L, 2017)*

Asynchronous modules (3.2.1) will allow students to engage with course materials at their own pace, providing flexibility for those with varying schedules. This will include recorded lectures, readings, assignments, and discussion forums where students can interact and share ideas.

Synchronous online sessions (3.2.2) will involve live virtual meetings using platforms such as Google Meet, Microsoft Teams, and Zoom. These sessions will enable real-time interaction, discussions, and collaborative activities, ensuring that students receive immediate feedback and support from instructors and peers.

By integrating both in-class and online training methods, the nZEBRA course aims to provide a comprehensive and flexible educational experience that caters to the diverse needs of its participants.

3.2.1. Asynchronous Modules

Asynchronous learning, where students can learn at different times according to their own schedules, will be a particularly good fit for the nZEBRA project. This type of learning does not require consistent real-time interactions with an instructor, unlike synchronous learning, which involves scheduled classes and simultaneous participation. The flexibility of asynchronous learning allows students to engage with the course material at their own pace, making it easier for those with varying schedules and commitments to participate fully.

By incorporating an asynchronous module into the nZEBRA course, students can access lectures, readings, and assignments at any time, enabling them to balance their studies with other responsibilities. This is especially beneficial for the diverse group of participants in the nZEBRA project, which includes students, early researchers, and technical professionals who may have different time constraints. Additionally, asynchronous learning promotes self-directed learning, encouraging students to take initiative and responsibility for their education. This flexible and accessible approach ensures that all participants can effectively engage with the course content and achieve the learning objectives related to climate neutral buildings.

3.2.1.1. What makes learning asynchronous?

When used in an educational context, asynchronous learning refers to courses where students access course materials—lectures, readings, and assignments—on their own time. Learning, in other words, takes place at all different times for students enrolled in a course, because there's no set class time.

Asynchronous learning can include:

- Watching pre-recorded lectures
- Undertaking independent research and writing projects
- Participating in an online discussion forum
- Watching online videos and taking a quiz to evaluate understanding.
- Completing a guided project
- Emailing with classmates when completing a team project

An in-person instructor may use elements of asynchronous learning to supplement a synchronous class. For example, they may choose to move one lesson online and have students complete it on their own time. Typically, asynchronous learning refers to online courses designed so students can learn on their own time. (Coursera, 2023)

3.2.1.2. Benefits of learning asynchronously

Asynchronous learning has gained a lot of popularity since the pandemic moved a good deal of education online. There are many benefits associated with learning asynchronously—let's go over a few of them:

- **Flexibility:** Because there are no set classes to attend, you can work on your studies in between your other obligations.
- **Self-paced:** Oftentimes, you can learn at your own pace, taking your time to fully grasp new concepts and become more familiar with key lessons.
- **Review:** You can return to past lessons or lectures to review something you might have missed.
- **Skills development:** Learning on your own schedule and at your own pace often requires a certain amount of drive and dedication. Learning with this structure often means you get the opportunity to refine valuable workplace skills, such as time management, attention to detail, and problem-solving. (Coursera, 2023)

3.2.2. Synchronous Sessions

Synchronous learning, where learners and instructors are in the same place at the same time for learning to take place, will be particularly beneficial for the nZEBRA project. This includes in-person classes and live online meetings when the whole class or smaller groups gather. In synchronous learning, students usually progress through the learning path together, with their instructor providing support as they complete tasks and activities.

While most online teaching happens asynchronously, synchronous learning is used when there is a specific need for live discussion or interaction, or as a strategy to build community among learners. Incorporating synchronous learning into the nZEBRA course can facilitate real-time interactions, allowing immediate feedback and support from instructors. This approach helps build a sense of community among participants, fostering collaboration and peer learning, which are crucial for understanding complex topics like climate neutral buildings. By blending synchronous learning with other instructional strategies, the nZEBRA project can create a dynamic and interactive learning environment that enhances student engagement and success. (Finol, 2020)

3.2.2.1. Benefits of Synchronous learning

- Synchronous learning has many benefits that make it a preferred choice for some. The biggest advantage is real-time interaction with the presenter, allowing immediate answers to questions. Instructors can also quickly gauge understanding and adjust the material as needed.
- Another key benefit is the instructor's constant presence to explain difficult concepts and provide immediate feedback. For those who prefer classroom learning but have job or family constraints, synchronous learning is a great alternative, offering a sense of community and interaction without the need for travel.
- Virtual-reality (VR) learning experiences are making online learning even more immersive, making learners feel like they are in a classroom. Synchronous eLearning also helps adult learners who are uncomfortable speaking in public, as they can type questions and comments into a chat box, giving them time to formulate their thoughts.
- Some synchronous courses do not require webcams, especially webinars where instructors address questions after presenting the material. This can be a plus for those who prefer not to be on camera. Fixed schedules of synchronous classes also provide structure, helping learners plan their day and stay organized. (Learning E. , 2022)

3.2.2.2. Disadvantages of Synchronous Learning

- A major disadvantage of synchronous learning is that the quality of training heavily depends on the instructor. Poor delivery, technical issues with presentations, or distractions during virtual meetings can all detract from the learning experience.

- Technological issues are common in synchronous eLearning. Live classes require a strong Internet connection, which can be more demanding than asynchronous courses where video quality can be adjusted for faster loading.
- Time zone differences can also be a significant problem since synchronous eLearning requires students to attend class at a specific time. Additionally, the pace is set by the instructor, not the students. This means if learners miss something or misunderstand a concept during the session, they may not have the chance to review it.
- To mitigate these issues, instructors can record synchronous sessions and make them available to those who cannot attend live. However, this turns the course into an asynchronous format, addressing the accessibility issue but losing the real-time interaction advantage. (Learning E. , 2022)

3.2.3. Discussion Forums

Discussion forums will play a crucial role in the nZEBRA project by providing a platform for continuous interaction, knowledge sharing, and community building among participants. These forums allow students to engage in meaningful discussions, ask questions, share insights, and collaborate on projects outside the constraints of scheduled class times. By facilitating asynchronous communication, discussion forums help ensure that all participants, regardless of their schedules, can contribute to and benefit from the collective learning experience.

Figure 5, illustrates "Online Discourse Technologies," showcasing various digital communication tools organized around a central concept. The central circle labelled "Online Discourse Technologies" is surrounded by smaller circles representing different methods of online communication. These include email, which is a traditional electronic messaging system for one-to-one or group communication; forums, which are online discussion boards for asynchronous communication and community engagement; chat, which provides real-time text-based communication; blogs, which are platforms for sharing articles, opinions, and updates; texting, which is a short messaging service for quick, often informal communication; and webinars, which are online seminars or workshops that allow for interactive learning and discussion. Collectively, these technologies facilitate various forms of online interaction and collaboration.

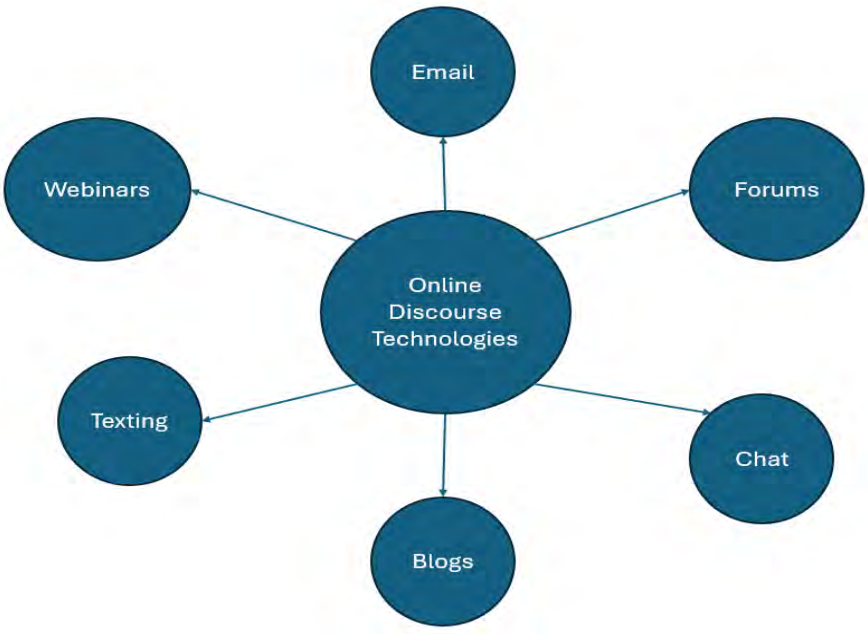

Figure 5: Examples of Online Discourse (L, 2017)

The importance of discussion forums lies in their ability to foster a collaborative learning environment where students can deepen their understanding of course material through peer interaction and collective problem-solving. They also provide a space for ongoing reflection and feedback, which are essential for continuous improvement and learning.

In the later part of this document, we will discuss various platforms that will support these interactive elements, including the Blackboard Platform 6.1, Google Meet 6.2.3, Microsoft Teams 6.2.1, and Zoom 6.2.2. These tools will be integral in enabling both synchronous and asynchronous interactions, supporting live discussions, and facilitating a seamless integration of various learning activities within the nZEBRA course.

4. Deductive, Learning Objectives and Outcomes in nZEBRA

The nZEBRA project aims to enhance sustainable building design and climate action skills through a comprehensive blended learning course focused on climate-neutral buildings. This course covers critical topics including nearly Zero Energy Buildings (nZEB), climate change adaptation, circular economy in construction recycling technologies, energy production and supply in buildings, smart buildings, environmental and social governance (ESG) strategies, and life cycle assessment (LCA) of buildings. The objective is to provide a flexible, student-centered learning experience, integrating both in-class and online methodologies to meet modern educational needs. The rationale for a user-centered approach is grounded in the recognition that successful energy transitions and climate-neutral buildings depend on widespread adoption and skillful engagement from stakeholders across energy and construction value chains. This approach ensures that the educational framework, composed of micro-credentials, is tailored to the specific needs and interests of the target audience. By understanding their knowledge level, concerns, and motivations, the micro-credentials can be designed to provide relevant and meaningful information, increasing engagement and participation.

The module-specific objectives of the nZEBRA course encompass a broad range of skills and knowledge areas. Students will gain a deep understanding of climate change adaptation and mitigation, climate modeling, and resilience strategies for urban energy systems and buildings. They will explore the challenges and opportunities of circular economy practices, including recycling and sustainability in construction. The course will cover innovative energy production technologies, building-integrated photovoltaics (BiPV), and energy storage solutions, emphasizing demand-side management for energy sustainability. Additionally, students will learn about smart building technologies, ESG strategies in construction, and the principles of LCA, preparing them to critically assess and optimize resource efficiency, reduce carbon footprints, and understand the policy and market implications of sustainable building practices. A user-centered approach identifies barriers and drivers for behavioural change and designs educational content to address these factors, leading to more successful adoption of sustainable energy practices and technologies. Involving the target audience in the development process empowers them to take ownership and responsibility for training and further uptake of acquired competencies. By acknowledging the diversity of needs, learning journeys, and styles, this approach ensures that educational micro-credentials are inclusive and accessible to all segments of the population, promoting widespread adoption of sustainable practices.

4.1. Modules-Specific Objectives

4.1.1. Climate Change adaption

- Understand the concepts of climate change adaptation/mitigation and their significance in the context of sustainable urban development.
- Explore the various impacts of climate change on buildings and energy systems, including extreme weather events.
- Familiarize with climate modeling techniques and downscaling methodologies for assessing climate change impacts at different spatial and temporal scales.
- Analyze the performance of buildings and integrated renewable energy systems under varying climate conditions, including extreme events.
- Gain insight into the resilience of different building technologies and renewable energy solutions in the face of climate change.

- Develop skills in generating and utilizing historical and future weather datasets for assessing energy and hygrothermal performance of buildings during typical and extreme climate events.
- Apply knowledge acquired through hands-on training and practical assignments to develop adaptation strategies for enhancing the resilience of urban energy systems and buildings against climate change impacts.

4.1.2. Circular Economy in Construction, Recycling Technologies:

- Gain a basic understanding of the challenges and opportunities of circular economy regarding recycling, reuse, and global technical, societal, and ethical aspects.
- Apply new knowledge in multidisciplinary groups for analysis of complex problems relevant to societal challenges due to increased amounts of waste and scrap, and especially residues within the construction industry.
- Present creative formulations on problems and/or solutions for critical considerations in terms of sustainable development concerning ecological and economic sustainability.
- Formulate requirements for suitable tools and measurements for specific circularity, and sustainability goals, in the construction industry.
- Problematizing how recycling and design can be organized in a circular economy by e.g. industrial symbiosis.
- Critically review and evaluate possibilities and limitations of technology within the energy and construction industry, from a global perspective.
- Critically analyze and assess tools, methods, and measures to achieve science-based sustainability impact for avoiding unwanted methods i.e. greenwashing.

4.1.3. Energy Production / Supply in Buildings:

- Understand the principles, technologies, and applications of energy sources in building infrastructure, including their environmental impact and sustainability considerations.
- Gain knowledge of innovative approaches to creating Smart Buildings and Nearly Zero Energy Buildings (nZEB) using renewable energy sources and energy-efficient design principles, including passive design strategies and active energy management techniques.
- Learn the principles, design considerations, and practical applications of Building-integrated Photovoltaics (BiPV) and Building-Applied Photovoltaics (BAPV) technology for seamless integration into building structures, considering architectural aesthetics, system efficiency, and economic feasibility.
- Develop skills in optimising the performance of BiPV/BAPV systems, considering architectural integration, system components, and regulatory requirements, and assessing their economic viability and return on investment.
- Learn about the importance of calibration and validation of energy building models, including data collection, model calibration procedures, sensitivity analysis, and uncertainty quantification, to ensure model accuracy and reliability for decision-making purposes.
- Gain knowledge of the design considerations and integration requirements for energy storage systems in building energy systems, including sizing, placement, and control strategies to optimize energy storage performance and maximize system efficiency.
- Acquire insights into emerging trends and advancements in energy storage technologies for buildings, such as grid-interactive buildings, vehicle-to-building (V2B) integration, and demand response programs, and their potential to enhance building energy resilience and contribute to grid stability and energy flexibility.
- Understand the concept and importance of demand-side management in the context of energy sustainability, grid reliability, energy flexibility, and environmental conservation.

- Acquire insights into Smart Building concepts and technologies, empowering users to dynamically adjust building energy and storage systems for enhanced energy efficiency and sustainability and evaluate the potential benefits and challenges of Smart Building implementation in various contexts.
- Apply theoretical and modelling knowledge and practical skills to analyze case studies and real-world examples, identifying best practices and lessons learned in energy production/supply systems for buildings, and develop innovative solutions to address emerging challenges in building energy management and sustainability.

4.1.4. Smart Buildings:

D3.5. with the topic Smart Building will consist of a comprehensive learning set that will provide students with specific and practical knowledge on building “smartness”, entailing the building’s ability to sense, interpret, communicate and actively respond to changing internal and external conditions as well as building occupants’ behavior.

- A smart building concept and why this is significant in today's world.
- Smart metering and data collection.
- Energy management in buildings tools.
- Smart readiness indicator (SRI).
- The basic principles of how new technologies and processes are used towards building smartness such as demand side management.
- Examples in which a building incorporated various smart technologies and processes.

4.1.5. Environmental, Social and Governmence Strategies:

- Gain basic understanding of EU Directives, legislation, regulations, and guides related to ESG.
- Gain a basic understanding of the challenges and opportunities of ESG regarding environmental impact, climate change, use of resources, and more from societal and ethical aspects.
- Apply new knowledge in multidisciplinary groups for analysis of ESG challenges especially within construction industry.
- Understand of what documents that are required for companies’ sustainability reporting, and ability to evaluate the reports from a perspective relevant for the construction industry.
- Understand of a strategic planning process in construction companies.
- Problematize and use of SWOT- analysis and other tools in the strategic planning process in a construction company case.
- Ability to use Change Management Models, in a given case.
- Critically review and evaluate possibilities and limitations of using ESG in construction industry, from a global perspective.

4.1.6. Life Cycle Assessment of Buildings:

- Develop a comprehensive understanding of the principles and methodologies underlying Life Cycle Assessment (LCA) as applied to the built environment.
- Learn to identify and analyze the environmental hotspots and critical stages within the life cycle of buildings.
- Acquire practical skills in applying LCA methodology, including goal and scope definition, inventory analysis, impact assessment, and interpretation, using industry-standard tools and software.

- Explore techniques to assess and optimize resource efficiency in building design, construction, and operation, considering factors such as material consumption, energy use, and waste generation.
- Understand strategies to assess and reduce the carbon footprint of buildings, integrating climate change considerations into sustainable construction practices.
- Gain insights into the role of LCA in policy development and compliance, understanding how LCA results contribute to shaping environmental regulations and standards in the construction industry.
- Gain a global perspective on environmental impacts, understanding the interconnectedness of environmental systems and ensuring that sustainability efforts do not result in unintended consequences.
- Develop skills in effectively communicating LCA findings to diverse stakeholders, including architects, engineers, policymakers, and the broader community, fostering collaboration and informed decision-making. (nzebra)

4.2. Expected Learning Outcomes

- The students will understand the basic concept of a smart building, LCA, climate change, energy building, etc.
- The students will gain the specific understanding and knowledge on the technological functionalities of the buildings, from an engineer's point of view.
- The students will specifically learn how to evaluate the building smart readiness in co-relation to the technical systems in the building
- The students will be able to recommend best way forward in making a building smarter
- The students will become familiar with energy management tool and its functionalities
- The students will gain basic knowledge on energy metering and technologies behind

5. Constructive Alignment and Pedagogical Approach Implementation

5.1. Learning outcomes

5.1.1. Climate Change adaption:

Students will demonstrate an understanding of the concepts of climate change adaptation and mitigation, articulating their significance in the context of sustainable urban development. They will evaluate the impacts of climate change on buildings and energy systems, including the effects of extreme weather events, and demonstrate proficiency in climate modelling techniques and downscaling methodologies to assess climate change impacts at various spatial and temporal scales. Students will analyse the performance of buildings and integrated renewable energy systems under different climate conditions, including extreme weather events, and gain the ability to assess the resilience of different building technologies and renewable energy solutions in response to climate change. They will develop skills to generate and utilize historical and future weather datasets for assessing the energy and hygrothermal performance of buildings during typical and extreme climate events. Additionally, students will apply their knowledge through practical assignments to create adaptation strategies that enhance the resilience of urban energy systems and buildings against climate change impacts.

5.1.2. Circular economy in Construction, Recycling Technologies:

Students will demonstrate a basic understanding of the challenges and opportunities associated with the circular economy, particularly in terms of recycling, reuse, and global technical, societal, and ethical aspects. They will effectively apply their knowledge in multidisciplinary groups to analyse complex problems related to societal challenges arising from increased waste and scrap, focusing on residues within the construction industry. Students will be able to present creative solutions and problem formulations for critical considerations in sustainable development, addressing both ecological and economic sustainability. They will formulate requirements for appropriate tools and measurements to achieve specific circularity and sustainability goals in the construction industry. Additionally, students will be able to problematize and propose ways to organize recycling and design within a circular economy, such as through industrial symbiosis. They will critically review and evaluate the possibilities and limitations of technology within the energy and construction industries from a global perspective, and critically analyse and assess tools, methods, and measures to achieve scientifically based sustainability impacts, avoiding methods that constitute greenwashing.

5.1.3. Energy Production / Supply in Buildings:

Students will demonstrate an understanding of the principles, technologies, and applications of energy sources in building infrastructure, including their environmental impacts and sustainability considerations. They will gain knowledge of innovative approaches to creating Smart Buildings and Nearly Zero Energy Buildings (nZEB) using renewable energy sources and energy-efficient design principles, including passive design strategies and active energy management techniques. Additionally, students will learn the principles, design considerations, and practical applications of Building-integrated Photovoltaics (BiPV) and Building-Applied Photovoltaics (BAPV) technologies, optimizing their performance while considering architectural aesthetics, system efficiency, regulatory requirements, and economic feasibility. They will understand the importance of calibration and validation of energy building models to ensure accuracy and reliability for decision-making. Students will also gain insights into the design and integration of energy storage systems, emerging trends in

energy storage technologies, and the concept of demand-side management for energy sustainability and grid reliability. Furthermore, students will explore Smart Building technologies and their implementation challenges and benefits. Through case studies and real-world examples, they will apply theoretical and practical knowledge to develop innovative solutions for building energy management and sustainability.

5.1.4. Smart Buildings:

Students will gain an understanding of the smart building concept and its significance in today's world, recognizing the importance of integrating advanced technologies for enhanced efficiency and sustainability. They will learn about smart metering and data collection, and how these tools contribute to effective energy management in buildings. Students will explore various energy management tools and the concept of the Smart Readiness Indicator (SRI), understanding its role in evaluating a building's capability to adapt to advanced technologies. They will grasp the basic principles of new technologies and processes, such as demand-side management, that contribute to building smartness. Additionally, students will study examples of buildings that have successfully incorporated various smart technologies and processes, analysing how these innovations improve building performance and sustainability.

5.1.5. Environmental, Social and Governmence Strategies:

Students will gain a basic understanding of EU Directives, legislation, regulations, and guides related to ESG, as well as the challenges and opportunities associated with ESG in terms of environmental impact, climate change, resource use, and societal and ethical aspects. They will apply this knowledge in multidisciplinary groups to analyze ESG challenges, particularly within the construction industry. Students will understand the documents required for companies' sustainability reporting and will be able to evaluate these reports from a perspective relevant to the construction industry. They will gain insights into the strategic planning process in construction companies and learn to utilize SWOT analysis and other tools in strategic planning. Additionally, students will develop the ability to apply Change Management Models in given cases and critically review and evaluate the possibilities and limitations of using ESG in the construction industry from a global perspective.

5.1.6. Life Cycle Assessment of Buildings:

Students will develop a comprehensive understanding of the principles and methodologies underlying Life Cycle Assessment (LCA) as applied to the built environment. They will learn to identify and analyze environmental hotspots and critical stages within the life cycle of buildings. Students will acquire practical skills in applying LCA methodology, including goal and scope definition, inventory analysis, impact assessment, and interpretation, using industry-standard tools and software. They will explore techniques to assess and optimize resource efficiency in building design, construction, and operation, considering factors such as material consumption, energy use, and waste generation. Students will understand strategies to assess and reduce the carbon footprint of buildings, integrating climate change considerations into sustainable construction practices. They will gain insights into the role of LCA in policy development and compliance, understanding how LCA results contribute to shaping environmental regulations and standards in the construction industry. They will gain a global perspective on environmental impacts, understanding the interconnectedness of environmental systems and ensuring that sustainability efforts do not result in unintended consequences. Additionally, students will develop skills in effectively communicating LCA findings to diverse stakeholders, including architects, engineers, policymakers, and the broader community, fostering collaboration and informed decision-making.

5.2. Pedagogical practices

The pedagogical approach for the nZEBRA project is designed to be flexible and adaptable, allowing partners to select and implement the most suitable methods for their specific modules. The following pedagogical practices are recommended:

1. **Constructivist Learning**: Emphasizes student-centered learning where students construct knowledge through experiences and reflections.
2. **Blended Learning**: Combines face-to-face instruction with online learning to maximize flexibility and engagement.
3. **Collaborative Learning**: Encourages group work and peer interactions to enhance understanding and problem-solving skills.
4. **Experiential and Hands-On Learning**: Focuses on practical, real-world activities that require active participation and critical thinking.
5. **Continuous Feedback and Reflective Practice**: Provides ongoing, constructive feedback and encourages students to reflect on their learning experiences for continuous improvement.
6. **Challenge Based Learning (CBL):** provides an efficient and effective framework for learning while solving real-world challenges. The framework fuels collaboration to identify big ideas, ask thoughtful questions, and identify, investigate and solve challenges. CBL helps learners gain deep subject area knowledge and develop the skills necessary to thrive in an ever-changing world.

5.2.1. Implementation

- **Constructivist Learning**: Modules can include projects, case studies, and problem-solving activities that require students to apply concepts in real-world contexts.
- **Blended Learning**: Online resources such as video lectures, discussion forums, and virtual labs can complement in-class sessions, offering a mix of synchronous and asynchronous learning opportunities.
- **Collaborative Learning**: Group assignments, peer reviews, and collaborative projects can be integrated to facilitate teamwork and knowledge sharing.
- **Experiential Learning**: Practical workshops, field visits, and simulations can provide hands-on experiences that reinforce theoretical knowledge.
- **Feedback and Reflection**: Regular quizzes, feedback sessions, and reflective journals can help students track their progress and identify areas for improvement.
- **Challenge-Based Learning**: Engage students with real-world challenges, guide them through collaborative research and critical analysis, and support them in developing and implementing practical solutions while reflecting on their learning process.

By incorporating these diverse pedagogical practices, the nZEBRA project aims to create a dynamic and effective learning environment that caters to the varied needs of its participants, ensuring a comprehensive understanding of climate-neutral building practices.

5.3. Assessment Strategy

In nZEBRA course, a well-rounded assessment strategy will be provided including a mix of formative and summative assessments, clear and relevant criteria, timely feedback, and continuous improvement to ensure fair, inclusive, and effective evaluation of student learning. The details of assessment strategy will be discussed in D2.3.

6.Learning Tools

6.1. Blackboard Platform (management tool)

Blackboard Learn, a versatile application designed for online teaching, learning, community building, and knowledge sharing, will be particularly beneficial for the nZEBRA project. Its open and flexible nature allows educators to implement any teaching theory or model to enhance student achievement. At Blackboard, the mission is to support learners and educators across various educational settings, from K-12 and higher education to adult learning and workplace training. As participants begin using Blackboard Learn, they will discover that online teaching has many parallels with traditional face-to-face classroom instruction. This platform will be integral in enabling both synchronous and asynchronous interactions, supporting live discussions, and facilitating a seamless integration of various learning activities within the nZEBRA course.

6.1.1. Course View

All your course content appears in the main part of the page, see Figure 6. When you open a content item, such as a test, it slides out in a panel on top of the Course Content page. Close the panel to go back to where you were previously.

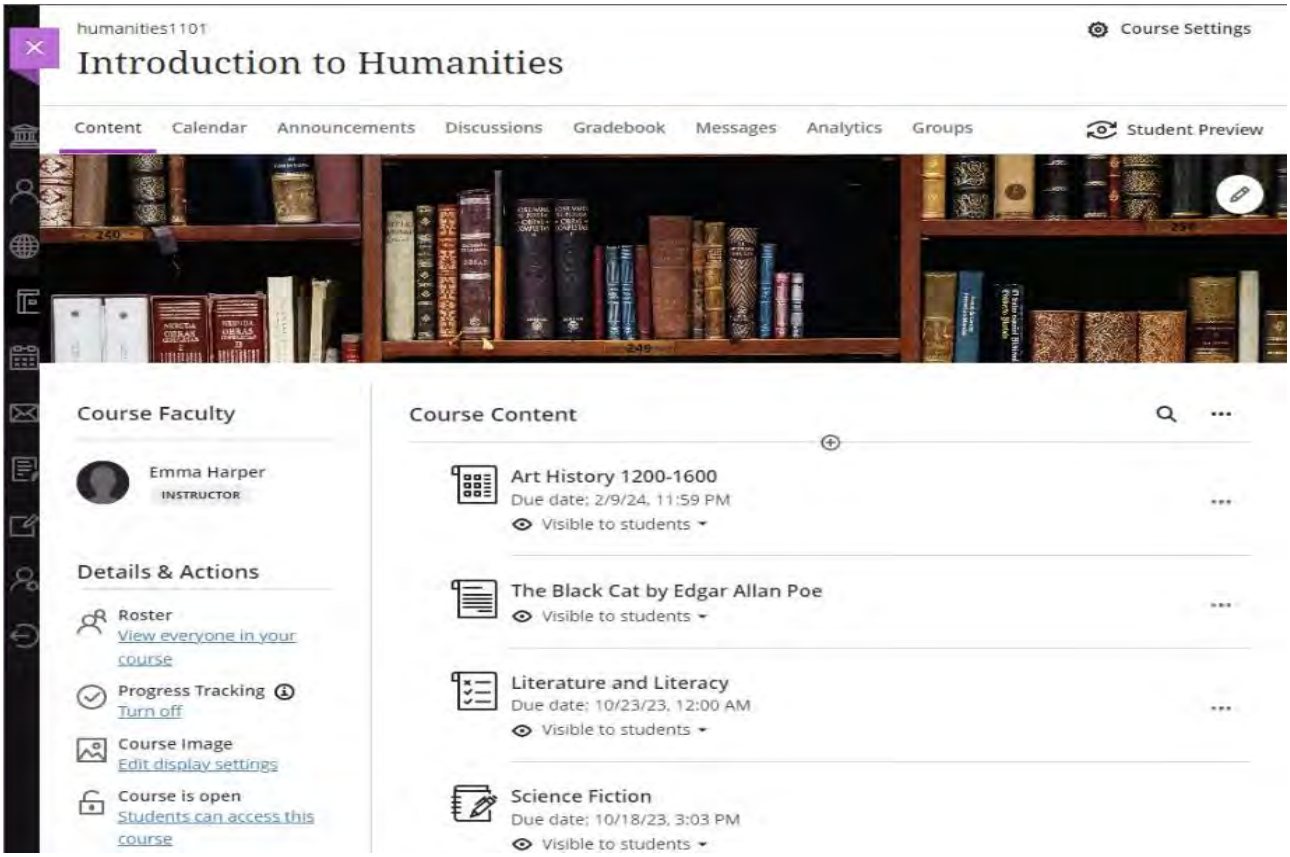

Figure 6: Blackboard Dashboard *(BlackBoard, 2022)*

- **Class Roster**: View and manage your class list, including accessing profile cards and sending messages.
- **Progress Monitoring**: Track student progress on course content and assessments, with an option to enable or disable this feature.
- **Course Personalization**: Add a course banner image to customize your course, displayed on the Course Content page and as a thumbnail.
- **Course Accessibility**: Open or make courses private while preparing content; students can see but not access private courses.
- **Collaborative Sessions**: Use Class Collaborate for scheduled or impromptu student workspaces.
- **Attendance Tracking**: Record attendance and access detailed records if this feature is enabled.
- **Available Tools**: Display tools available within your course and institution.
- **Question Bank Creation**: Create and reuse question banks for multiple assessments.
- **Teams Integration**: Set up a Team class if integrated with Microsoft Teams.
- **Class Scheduling**: Add class meeting times and locations to the calendar, with an option to skip or add later. (BlackBoard, 2022)

6.1.2. Create a test

Creating tests in Blackboard Learn is a streamlined process, enabling instructors to assess student understanding effectively. Anonymously submitted surveys are not supported, but tests always remain accessible to instructors. Tests can be integrated with other course materials, providing a cohesive preparation resource for students. To create a test, instructors navigate to the Course Content page, select the plus sign at the desired location, and choose "Create" from the menu to open the Create Item panel, then select "Test," which opens the New Test page. Content added during this process remains invisible to students until the instructor opts to make it visible, allowing for experimentation and adjustment (see Figure 7).

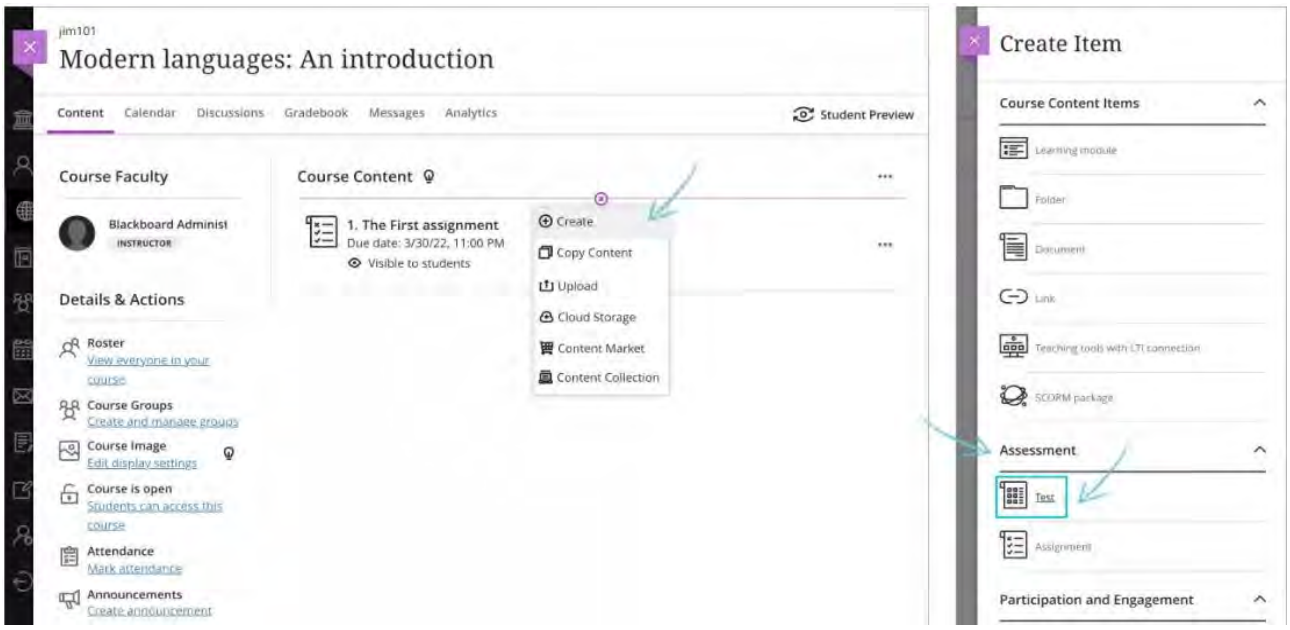

Figure 7: Blackboard Test Dashboard *(BlackBoard, 2022)*

6.1.3. Create Assignments

With assignments, coursework can be created, and grades and feedback managed separately for each student. Assignments can be created in content areas, learning modules, lesson plans, and folders (See Figure 8).

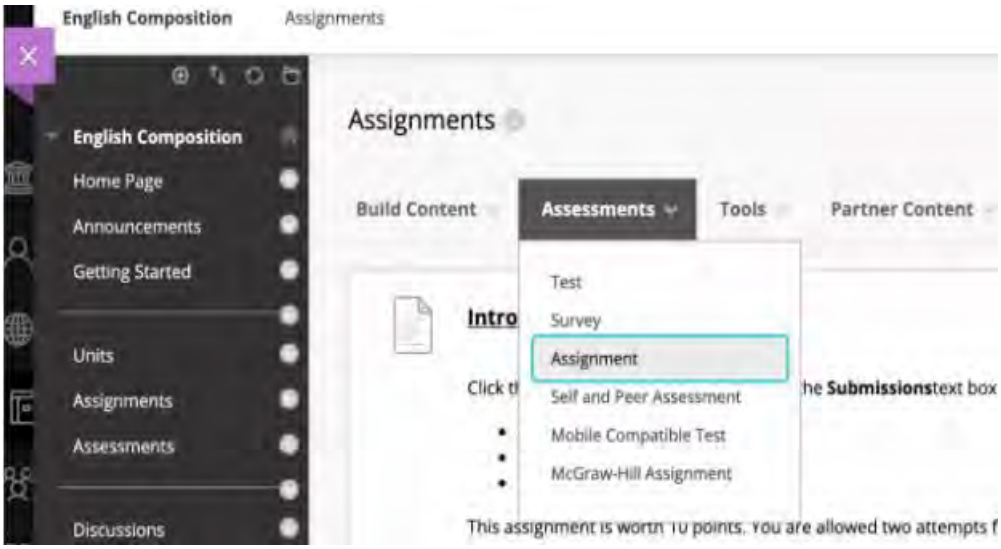

Figure 8: Create Assignments *(BlackBoard, 2022)*

When an assignment is created, a Grade Centre column is automatically generated. From the Grade Centre or Needs Grading page, it is possible to see who has submitted their work and begin grading. Students access their grades from their My Grades pages or the assignment's Review Submission History page.

Group assignments can also be created and released to one or more groups in the course. Each group submits one collaborative assignment, and all members receive the same grade. A single assignment can be assigned to all groups, or several unique assignments can be created and assigned to individual groups.

6.1.4. Gradebook

Tracking changes made to grades in a course is essential for instructors and administrators for audit purposes. The grade history records offer a valuable audit trail, which is beneficial for addressing

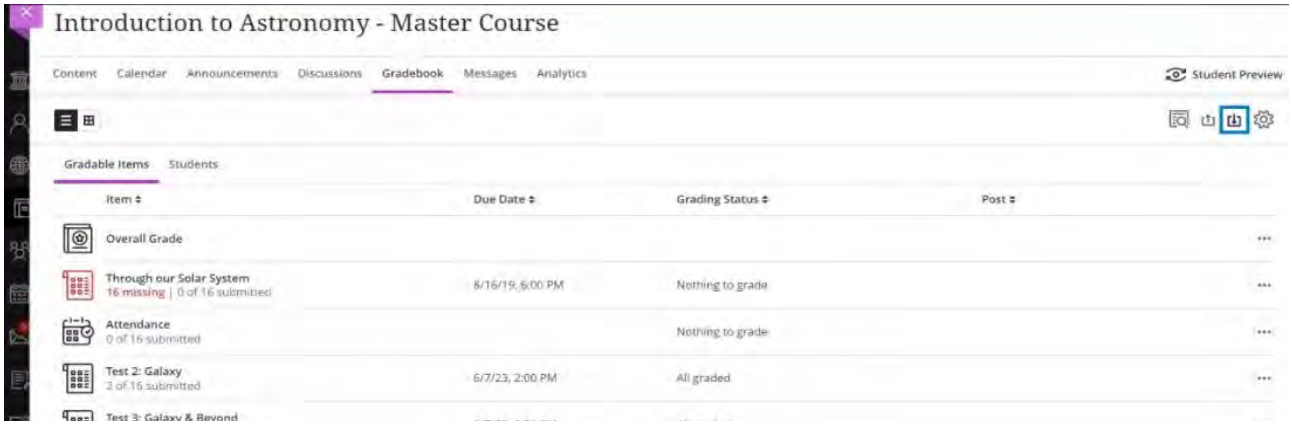

Figure 9: Gradebook *(BlackBoard, 2022)*

student questions and grade challenges. These records can be downloaded from the gradebook (see Figure 9).

6.1.5. Question analysis

Question analysis provides statistics on overall performance, assessment quality, and individual questions, helping to identify questions that may not effectively discriminate student performance. It applies to assessments with questions and can be run before all submissions are received to check and improve question quality. Uses for question analysis include improving questions for future assessments or adjusting credit on current attempts, discussing assessment results with the class, providing a basis for remedial work, and enhancing classroom instruction (See Figure 10).

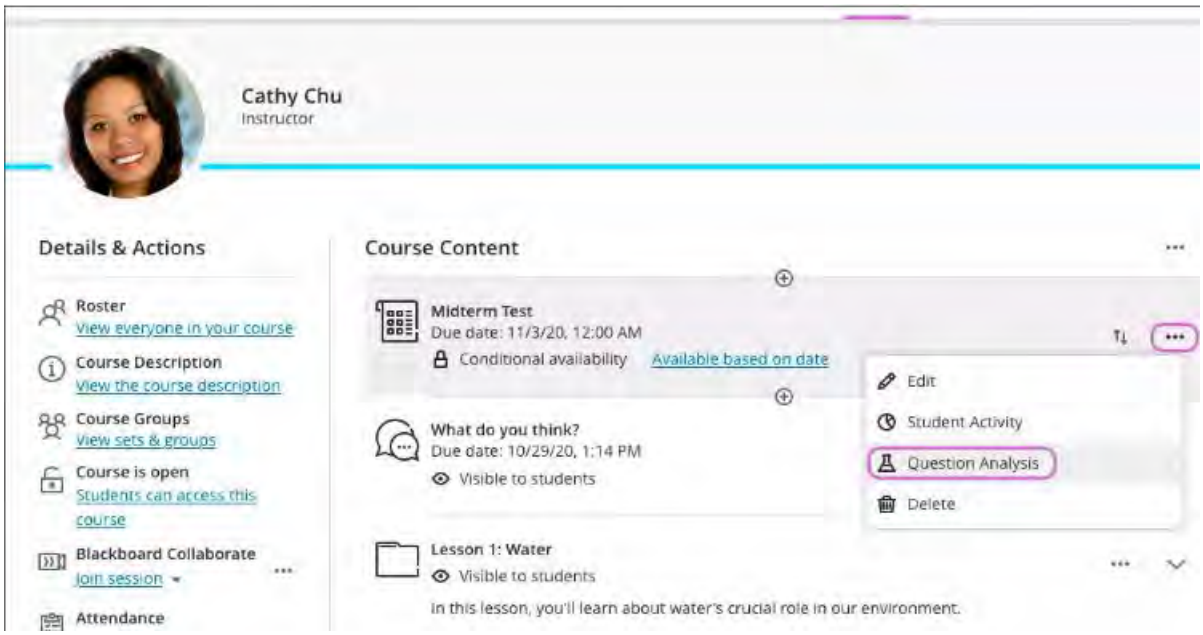

Figure 10: Question Analysis *(BlackBoard, 2022)*

6.1.6. Multiple grading schemas

Up to 100 grading schemas can be created per course, allowing flexibility in using the most appropriate grading schema for each assessed activity (See Figure 11).

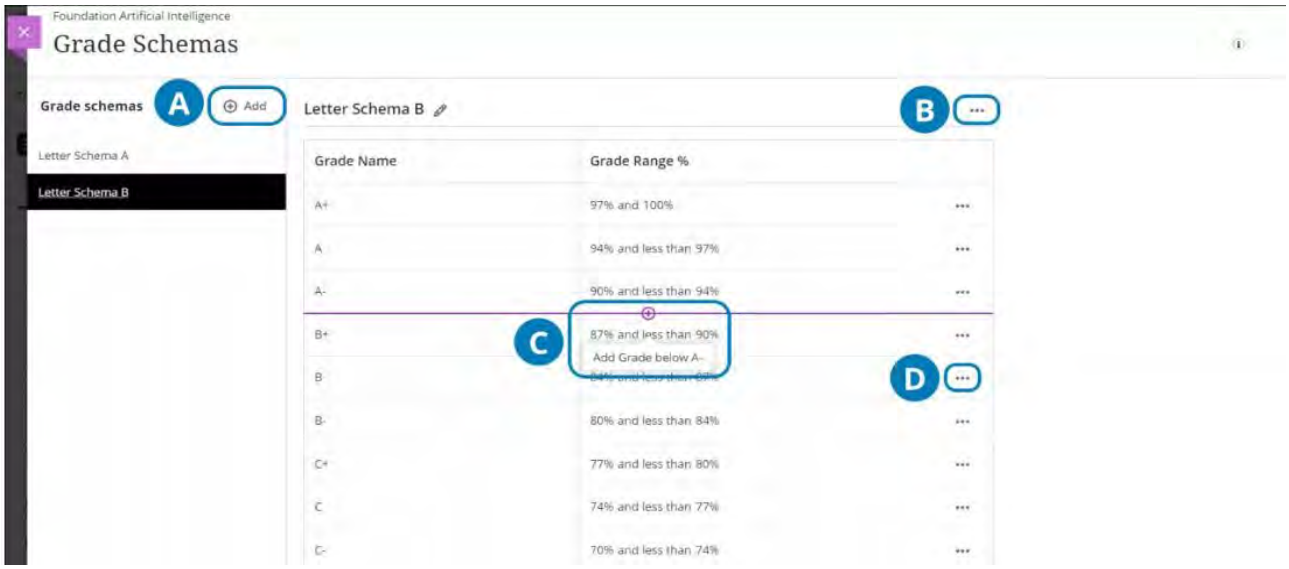

Figure 11: Grading Schemas *(BlackBoard, 2022)*

6.1.7. Announcements inside a course

New course announcements appear as a pop-up window the first-time students enter a course. Students must close the New Course Announcements window before they can access course content. Once closed, the window will not appear again unless new announcements are posted. If new announcements are posted, the window will reappear, showing only the new announcements (See Figure 12).

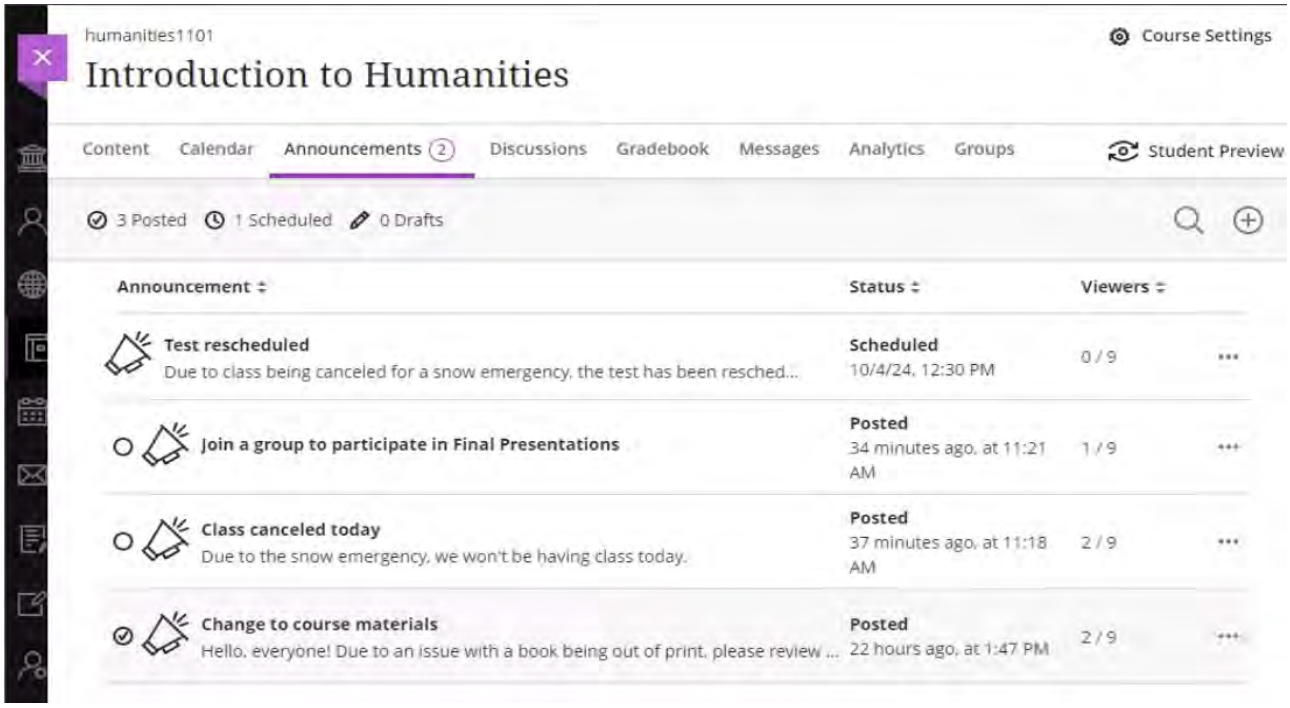

Figure 12: Announcements inside a course *(BlackBoard, 2022)*

- **View a summary of your announcements.** View the number of course announcements by status at the top of the page. Announcements have three statuses: Posted, Scheduled, and Draft.
- **Sort columns.** Sort announcements by the title, status, or the number of viewers.
- **Search announcements.** Select the Search announcements icon that's displayed as a magnifying glass and enter keywords to locate a specific announcement.
- **Create a new announcement.** Select the plus sign icon to open the New Announcement page.
- **Manage announcements.** Open an announcement's menu to edit, copy, or delete an announcement.
- **Mark as read.** Select the circle beside an announcement to set an announcement to read or unread. (BlackBoard, 2022)

6.1.8. Messages inside a course

In a course, select the Messages page to manage your course communications. The number of unread messages is indicated by a red circle. All course messages and responses are displayed on the Messages page, allowing for easy review and access (See Figure 13**: Messages inside a course**

Figure 14Figure 13).

Unread messages appear first in the list, marked with a red circle next to the sender's name. Each message includes the sender's profile picture, and under the sender's name, the number of participants or an indication if the message is for the whole class is shown.

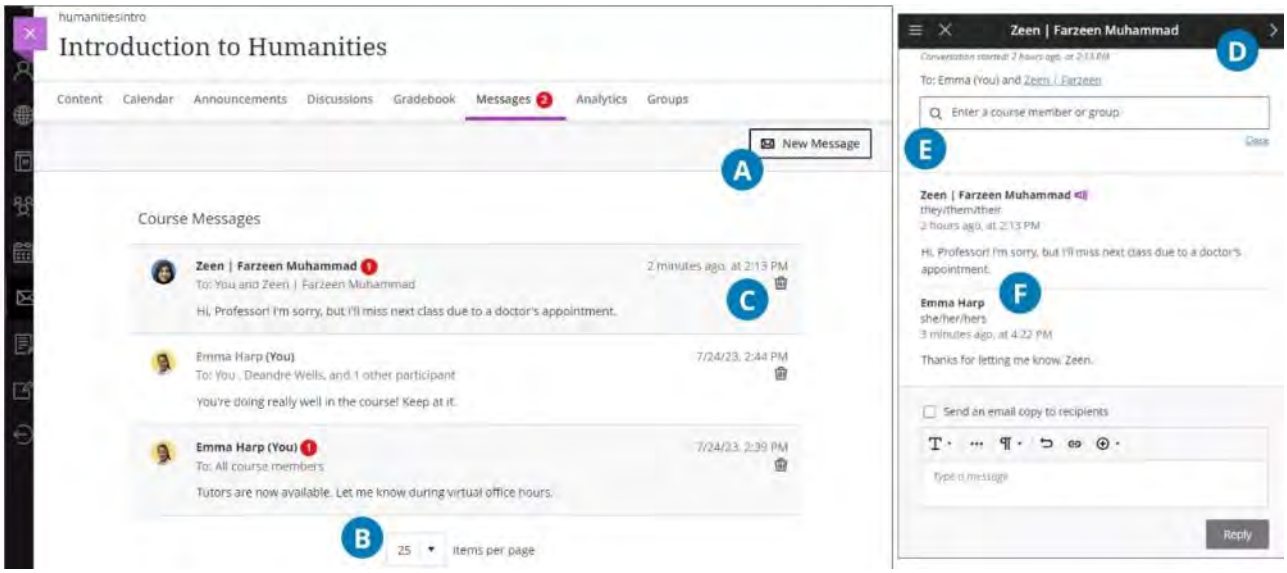

Figure 13: Messages inside a course *(BlackBoard, 2022)*

Figure 14Figure 15: Messages inside a course *(BlackBoard, 2022)*

- **Send a message**: Select the New Message button to send a message to one-person, multiple people, a group, or the entire class.
- **Select how many messages per page**: If there are many messages, the display can be adjusted to show more messages on one page.
- **Delete a message**: Use the Delete button to remove a message. If more responses are received, they will still appear. Individual responses within a message cannot be edited or deleted.
- **Navigate to another message**: Messages open in a panel with all responses. Use the View Previous Messages and Next Message buttons at the top to navigate through messages.
- **Add more people**: When creating or responding to a message, the Add Participants button can be used to include additional people, unless the message was sent to the entire class. Original recipients will see a note in the next message indicating new participants, while new recipients will see the message from the point they were added.
- **Follow a conversation**: Messages are threaded, displaying every sent and received message within a conversation when selected. The most recent message in a thread is displayed on the course's Messages page. Messages sent by the user are marked with "(You)" next to their name.

6.1.9. Blackboard Assist

Your institution can highlight two Featured Services, with all other services listed below them. Each service includes the service title, description, and category. Institutional services are highlighted with your institution's logo. Some services require creating an account to use. Select "Try it out" to preview the service without an account. If an account is created, the service remains accessible through the Assist page (See Figure 14**: Blackboard Assist**

Figure 14).

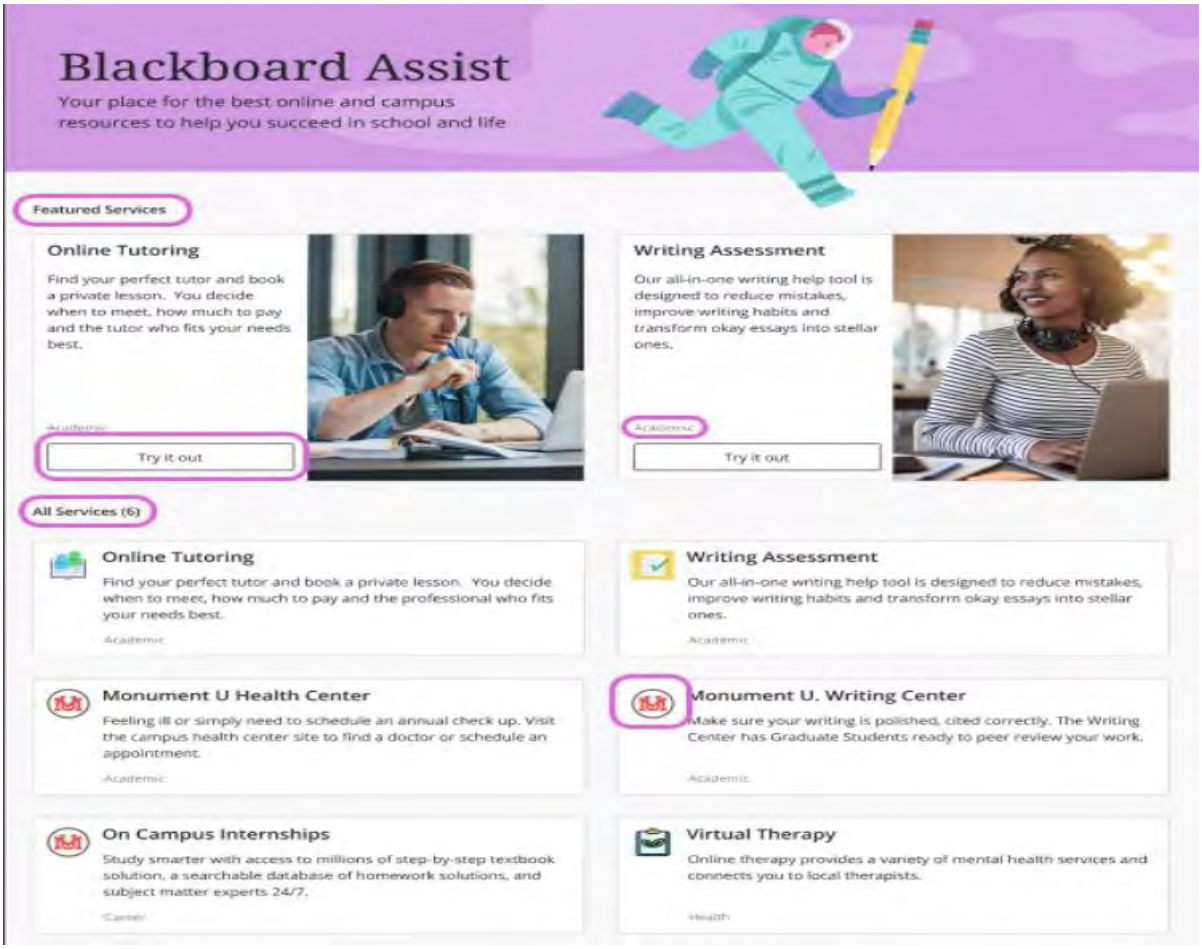

Figure 16: Blackboard Assist *(BlackBoard, 2022)*

Figure 17: Blackboard Assist *(BlackBoard, 2022)*

6.2. Multimedia and Communication platform

6.2.1. Microsoft Teams for Learning

Microsoft Teams is a collaborative platform that integrates with Office 365, offering a comprehensive solution for communication, file sharing, and collaboration. It is particularly suitable for educational institutions due to its extensive features and integration capabilities.

6.2.1.1. Features

- Seamless access to Word, Excel, PowerPoint, and OneNote within the Teams environment.
- Includes chat, video conferencing, and voice calls.
- Real-time document editing, file sharing, and project collaboration.

- Teachers can create and manage classes, assign and grade homework, and provide feedback.
- Robust security features, including data encryption and compliance with educational standards.

6.2.1.2. Advantages

- All-in-one platform for communication and collaboration.
- High levels of data protection and privacy controls.
- Suitable for institutions of all sizes.
- Deep integration with other Microsoft tools and services.

6.2.1.3. Disadvantages

- Extensive feature set can be overwhelming for new users.
- Requires significant bandwidth and computing resources.

Best Use Case: Ideal for institutions that are already using Microsoft Office 365 and need a comprehensive, integrated solution for communication and collaboration.

6.2.2. Zoom for Learning

Zoom is a popular video conferencing tool known for its ease of use and reliability. It is widely used in educational settings for live classes, webinars, and virtual meetings.

6.2.2.1. Features

- High-quality video and audio for large and small meetings.
- Allows splitting participants into smaller groups for discussions and group work.
- Supports large-scale online events with up to thousands of participants.
- Ability to record sessions for later review and distribution.
- Easy sharing of screens, applications, and whiteboards.

6.2.2.2. Advantages

- Intuitive interface, easy to set up and use.
- Consistent performance even with large numbers of participants.
- Tools like breakout rooms and virtual backgrounds enhance the learning experience.
- Can be accessed from various devices, including smartphones and tablets.

6.2.2.3. Disadvantages

- Past concerns over security and privacy, though many have been addressed.
- Advanced features and larger meeting capacities require paid plans.

Best Use Case: Best suited for institutions that need a reliable and user-friendly platform for live online classes, webinars, and meetings, especially where visual interaction is crucial.

6.2.3. Google Meet for Learning

Google Meet is a video conferencing service that is part of Google Workspace (formerly G Suite). It offers simple and effective communication tools integrated with other Google services.

6.2.3.1. Features

- Works seamlessly with Gmail, Google Calendar, Google Drive, and Google Classroom.
- Supports video calls with up to 250 participants.
- Integrated with Google Docs, Sheets, and Slides for real-time document collaboration.
- Option to record meetings and save them to Google Drive.
- Strong security measures, including encryption and secure login.

6.2.3.2. Advantages

- Easy to use, especially for users familiar with Google services.
- Excellent integration with Google Workspace tools.
- Works well on various devices, including Chromebooks, which are popular in education.
- Free for basic use, with affordable plans for advanced features.

6.2.3.3. Disadvantages

- Fewer advanced features compared to Zoom and Teams.
- Less sophisticated management of large meetings and webinars.

Best Use Case: Ideal for schools and institutions already using Google Workspace, looking for a straightforward and integrated solution for video conferencing and online collaboration.

6.3. Open LCA Tool:

openLCA is the world's leading high-performance, open-source Life Cycle Assessment software, designed for comprehensive Sustainability and Life Cycle Assessments. It offers fast and reliable calculations, providing detailed insights into analysis results to identify main drivers throughout the life cycle by process, flow, or impact category, with results that can be visualized and mapped. The software boasts best-in-class import and export capabilities, making model sharing seamless. It integrates Life Cycle Costing and social assessment within the life cycle model smoothly. With a user-friendly interface available in multiple languages and an advanced repository and collaboration feature under development, openLCA continuously improves and implements new features to enhance user experience and functionality. (Delta, 2024)

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7.Conclusions

This report summarized the pedagogical approach and methodological framework and course syllabus for nZEBRA's course. In this deliverable, we provided detailed understanding of blended learning approach that is tailored to modern educational needs for nZEBRA's course. Here, we discussed both in-class and online learning methodologies to provide a comprehensive educational experience in nZEBRA project.

We also defined in D2.2, general learning objectives and outcomes, alongside relevant didactic methods, assistive digital tools, and a balanced mix of in-class and online sessions. The deliverable emphasized the implementation of constructivist and collaborative learning models. Additionally, D2.2 presented experiential and hands-on learning approach as another key aspect of the pedagogical framework in nZEBRA project.

In this report, we provided the objectives and outcomes of each nZEBRA's modules and also discussed on their learning outcomes and assessment strategies. Moreover, we also discussed the pedagogical and methodology framework including mechanisms for continuous feedback and reflective practice.

This report provides detailed information on Blackboard as advanced learning tools and platform that play a crucial role in supporting nZEBRA's pedagogical implementation. We also discussed the multimedia and communication tools to facilitate both synchronous and asynchronous learning activities in nZEBRA project.

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