

WP3: ECOTEACH Virtual Classroom



CONCEPTUAL AND PEDAGOGICAL
FRAMEWORK



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Teaching Science and Maths through Innovative Models of Environment-Based Learning for Disadvantaged Schools and Students (ECOTEACH)

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Coordinator



DSEL

Directorate of Secondary Education of Lassithi

Partners



Work Package 3

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Edited by: DISRUPTIA

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This document presents the Conceptual and Pedagogical Framework developed under Work Package 3 / Activity 4 (WP3/A4) of the ECOTEACH project. Its purpose is to provide the common educational and methodological foundation for the ECOTEACH Virtual Classroom, supporting teachers and educators in implementing Environment-Based Learning (EBL) approaches to Science and Mathematics, particularly in disadvantaged educational contexts.

The Framework is organised around six interconnected Learning Units covering the main pedagogical dimensions of ECOTEACH: Environment-Based Learning foundations, inclusive STEM education, interdisciplinary Mathematics and STEM integration, digital tools, community engagement and project-based learning, and assessment in disadvantaged contexts. Each Learning Unit combines theoretical foundations, pedagogical approaches, practical applications and recommendations for educators.

The Conceptual and Pedagogical Framework provides a coherent reference for the development of the other components of the ECOTEACH Virtual Classroom, including the Electronic Database, Hands-On Exercises, Evaluation Methods and Tools and the Online Training Course. It therefore helps ensure pedagogical consistency, inclusion, practical relevance and transferability across the educational resources developed within WP3.

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1. About the Conceptual and Pedagogical Framework

The ECOTEACH Conceptual and Pedagogical Framework (WP3/A4) provides the common educational foundation for the development of the ECOTEACH Virtual Classroom. It connects the Learning Outcomes and Competences defined in WP2 with the practical resources, activities and training materials developed throughout WP3.

The Framework is designed as a practical reference for teachers and educators, rather than as an academic review. It explains how Environment-Based Learning (EBL), STEM education, inclusive pedagogy, active learning and digital approaches can be combined to create meaningful and accessible learning experiences, particularly in disadvantaged educational contexts.

Its pedagogical principles guide the development and use of the Electronic Database, Hands-On Exercises, Evaluation Methods and Tools and Online Training Course, helping ensure coherence across the different components of the ECOTEACH Virtual Classroom.

2. Pedagogical approach and learning structure

The ECOTEACH Conceptual and Pedagogical Framework is based on Environment-Based Learning (EBL), using real environmental contexts and sustainability challenges as meaningful settings for teaching and learning Science and Mathematics. This approach encourages learners to connect STEM concepts with their surroundings, investigate real-world problems and develop knowledge and competences through active participation.

The pedagogical approach combines inquiry-based learning, experiential and hands-on learning, project-based learning, collaborative learning and the appropriate use of digital tools. Particular attention is given to inclusive and accessible education, supporting disadvantaged learners and diverse educational contexts through flexible teaching strategies, differentiated learning and Universal Design for Learning (UDL) principles.

The Framework is structured around six interconnected Learning Units, each addressing a key dimension of Environment-Based STEM education:

- LU1 – Foundations of Environment-Based Learning (EBL) in STEM Education
- LU2 – Designing Inclusive STEM Learning Activities through EBL
- LU3 – Integrating Mathematics and STEM Content into EBL
- LU4 – Digital Tools and Resources for Enhancing EBL in STEM
- LU5 – Community Engagement and Project-Based Learning in EBL
- LU6 – Assessment and Impact Evaluation of EBL in Disadvantaged Contexts

Together, the six Learning Units provide teachers and educators with a progression from the conceptual foundations of EBL to its practical implementation, adaptation and evaluation. Each unit combines theoretical foundations with pedagogical approaches, practical applications and recommendations that can be adapted to different learners, schools and educational environments.

3. From Learning Outcomes to Pedagogical Practice

The ECOTEACH Conceptual and Pedagogical Framework builds directly on the six Learning Units and Learning Outcomes established in WP2. While the Learning Outcomes Framework defines what teachers should know, understand and be able to do, the present Framework translates these outcomes into pedagogical approaches, teaching strategies and practical guidance for their application in Environment-Based STEM education.

Each Learning Unit therefore connects the established Learning Outcomes with relevant theoretical foundations, inclusive and active learning methodologies, practical applications and recommendations for educators. This ensures continuity between the ECOTEACH curriculum and its practical implementation within the Virtual Classroom.

The Framework also provides the pedagogical basis for the development and use of the other WP3 resources, including the Electronic Database (A3), Hands-On Exercises (A5), Evaluation Methods and Tools (A6) and Online Training Course (A8).

4. Learning Units

Learning Unit 1

Foundations of Environmental-Based Learning (EBL) in STEM Education

Learning Unit 2

Designing Inclusive STEM Learning Activities through Environmental-Based Learning

Learning Unit 3

Integrating Mathematics and STEM Content into EBL

Learning Unit 4

Digital Tools and Resources for Enhancing EBL in STEM

Learning Unit 5

Community Engagement and Project-Based Learning in EBL

Learning Unit 6

Assessment and Impact Evaluation of EBL in Disadvantaged Contexts



4.1 Learning Unit 1: Foundations of Environmental-Based Learning (EBL) in STEM Education

Introduction

Learning Unit 1 introduces the fundamental principles of Environment-Based Learning (EBL) and its implementation in STEM education. By focusing on its core principles, key concepts, and relevance for teaching science and mathematics, particularly in disadvantaged school contexts, it aims to equip teachers with both theoretical and practical skills to implement EBL in STEM education. In this context, the unit serves as the conceptual starting point for establishing a pedagogical basis grounded in subsequent learning units and practical applications.

In many disadvantaged school settings, students often experience difficulties engaging with abstract scientific and mathematical concepts that appear disconnected from their daily lives. Traditional teaching approaches may therefore limit students' participation, motivation and long-term understanding. This learning unit addresses these challenges by encouraging teachers to connect STEM learning with students' immediate environments and lived experiences.

The unit explores key concepts such as environmental awareness, sustainability, place-based learning and experiential education. Through these perspectives, teachers are encouraged to view the local environment as a meaningful pedagogical resource that can support active participation, critical thinking and interdisciplinary learning.

As the introductory unit of the ECOTEACH framework, it provides the conceptual and pedagogical foundation for the following learning units and practical classroom applications. It particularly aims to strengthen teachers' confidence and readiness to implement Environment-Based Learning approaches in diverse and resource-limited educational settings.

Theoretical foundations

This learning unit focuses on the key pedagogical theories and approaches to effectively integrate Environment-Based Learning into STEM activities, specifically targeting implementation in disadvantaged contexts. The grounding approach in this unit situates learning within local environmental contexts rather than an isolated and theoretical traditional teaching approach. By this contextualization, students will be better able to develop a deeper understanding of scientific and mathematical concepts, particularly in disadvantaged settings.

Environment-Based Learning (EBL) constitutes the core theoretical framework of the unit, which situates the environment as an enriching and dynamic learning context. To connect learning experiences to the students' immediate environment, students explore real-world issues and understand the interconnections between ecological, social and scientific systems.

Inquiry-Based Learning encourages students to investigate a phenomenon or solve an authentic problem they have experienced/observed in their immediate surroundings, thereby reinforcing both scientific thinking and problem-solving skills. In this approach, students are engaged in observation, data collection and analysis processes.

Experiential Learning further reinforces these processes by encouraging active engagement at every stage of the learning process. Students interact directly with their surroundings, which makes learning more meaningful and permanent. This approach is particularly effective for students from disadvantaged backgrounds, as it supports understanding beyond traditional.

Inclusive Education Approaches ensure that learning opportunities are accessible and meaningful for each student who comes from different backgrounds. By incorporating flexible teaching strategies and adapting to diverse learning needs, teachers can foster participation and reduce learning inequalities by creating supportive environments. Approaches such as Universal Design for Learning (UDL) provide multiple ways for students to engage with content and demonstrate their understanding.

Social Constructivist Perspectives, influenced by Vygotsky, also play an important role in the unit. Collaborative learning environments encourage students to exchange ideas, learn from peers and develop understanding through social interaction. This is especially beneficial in diverse classrooms where students may demonstrate different learning needs and abilities.

Finally, STEM education integrates science and mathematics through interdisciplinary learning. These disciplines are naturally connected by environmental topics, enabling students to apply mathematical tools such as measurement, data analysis and interpretation within scientific systems. This integrated approach fosters the development of transferable skills, such as problem solving, critical thinking and collaboration.

Together, these theoretical foundations support the development of engaging, inclusive and context-based STEM learning experiences, particularly in schools with limited resources and diverse student populations.

Pedagogical approach

This learning unit is implemented through student-centred teaching methodologies that promote active learning, student engagement, and inclusive participation. These approaches enable teachers to effectively integrate EBL into STEM education, especially in disadvantaged school contexts. As a foundational unit, it aims to upskill teachers' capacity to implement key

pedagogical approaches before moving into more practice-oriented applications in subsequent units.

At this level, inquiry-based learning is presented as a mindset rather than a fully structured methodology. Teachers are encouraged to facilitate learning by providing simple, open-ended environmental prompts (e.g. 'What do you observe around our school?' or 'Where do you see mathematics in our daily environment?'). This mindset helps to shift the focus from theory to exploration, which enhances active engagement, particularly among students who may feel disconnected from abstract STEM concepts.

The unit also presents the logic of project-based thinking by equipping teachers with an understanding of real-world environmental problems to be used as entry points for STEM education, to support students' motivation and engagement.

The key strategy for creating supportive and participatory science and maths lessons is collaborative learning. Practical application examples in this unit highlight peer interaction and inclusive classroom environments. The overall aim is to provide teachers with the mindset and practical tools to implement this approach further.

Digital-supported learning increases accessibility among students and diversifies the lesson materials. Digital tools can be used as observation tools such as taking photos of observations, creating basic digital charts, or presenting findings visually. In this context, teachers are encouraged to utilize the ECOTEACH Virtual Classroom as a supportive tool, which provides structured materials, interactive content, and examples of practice.

Importantly, the unit emphasises that effective STEM learning does not require advanced equipment or expensive materials. Everyday surroundings, local environmental issues and low-cost resources can become meaningful learning opportunities when combined with active and inclusive teaching approaches.

Practical application in schools

Starting from simple and flexible real-world situations that are familiar to students, it is highly encouraged to take initial steps in integrating Environment-Based Learning (EBL) into their classroom practices.

- For example, a teacher may begin the lesson by asking a simple question such as: "What kind of waste do we throw away the most in our classroom?", or "Where do we observe the most pollution in our neighborhood?, Why do you think?". Teacher may encourage students to observe their school/classroom/neighborhood and collect simple data over a few days. Students can be encouraged to define their own categories (e.g., plastic, paper, food waste, or, based on colors/texture), encouraging active thinking in the learning process. As the students record their findings, the teacher introduces basic mathematical concepts such as counting, comparing quantities and representing results visually through simple charts. This approach ensures that mathematics is not taught as an abstract subject, but as a tool for understanding real-life situations.

Similarly, teachers can design learning experiences that evolve over time.

- For example, during a plant observation activity, students could be asked to predict how a plant would grow in different conditions, such as sunlight, water and location. They can then measure and record changes regularly. This process helps students to move from observation to reasoning, thereby bridging the gap between experience and conceptual understanding.

To make learning more inclusive, teachers could organize activities so that each student has the chance to take on different roles. For example, some students could measure, some could record data, and some could present the results.

Teachers are further encouraged to connect these activities to students' daily lives by asking reflective questions:

- "Why is this important for our school?" or "What could be changed on this matter?"

Teachers are encouraged to make students explore their surroundings by asking questions:

- "Which areas are always in the sun? Which areas are mostly in shadow? Why do you think?" or "Where do you see sunlight in the morning?"

Students can then record where shadows appear and which areas receive more sunlight. They can compile these recordings and create a chart based on them.

Students can also use simple apps to measure environmental data, take photos of observations, and use basic graphing tools. Interactive tools such as quizzes, visual simulations, or collaborative platforms can also support engagement and allow students to participate in different ways. This could not only provide visual support but also enable students to better understand and reflect on their findings, particularly benefiting those with diverse learning needs or language barriers.

An example to implement in the classroom:

- **"Where does water come from? Where does water go?"**

This activity aims to introduce students to basic system thinking by encouraging them to think and explore how water moves through their immediate environment. This activity involves observation, questioning, and simple reasoning, while also bridging science concepts with their surroundings.

- ➔ Phase 1: This activity starts with an observation. Students explore the school and the surrounding area to observe where water can be found and how it is used (e.g. in sinks, drinking fountains, in the garden, in puddles after rain or flowing along the street). The teacher can guide the students by asking simple questions such as "Where can we see water?" and "What happens to water after it has been used?"

- Phase 2: Students reflect on their observations and attempt to trace the journey of water, answering questions such as:
 - Where does the water come from?
 - Where does it go after we use it?
 They represent their ideas by drawing simple flow diagrams (e.g. tap → use → drain), which allows them to visualize processes even if they cannot fully explain them verbally.
- Phase 3: Students present their diagrams to the class. Teacher can support the discussion by comparing different ideas and highlighting similarities and differences. This stage helps students articulate their thinking and learn from their peers.
- Phase 4: Teacher encourages deeper thinking through questions such as:
 - Where might water be wasted?
 - What could we do to use water more carefully?

Students may suggest simple, realistic actions (e.g., turning off taps, using less water, being more careful in daily use). After simple actions, students may be encouraged to develop more advanced and creative solutions, such as water reuse strategies, rainwater collection, or awareness-raising initiatives within the school environment. Following this discussion and based on your student group and available resources, these ideas can be developed further into small-scale classroom or school projects following this discussion.

These gradual and flexible practices enable teachers to help students experience science and mathematics as part of their everyday lives. This is to break down barriers to participation, promote inclusive learning and establish a solid basis for more structured, inquiry-based activities in STEM education.

Conclusions and recommendations

Implementing Environment-Based Learning (EBL) in STEM education has the potential to make science and mathematics more accessible, engaging and meaningful for all students, especially those in disadvantaged schools. By connecting learning to real-life environmental situations, teachers can reduce participation barriers and promote the development of key competencies more inclusively.

To effectively apply this approach, teachers are encouraged to start with simple activities that build on students' immediate surroundings. Using the classroom, schoolyard or local neighbourhood as a learning resource enables teachers to create meaningful learning experiences without the need for advanced materials or infrastructure. This is particularly important in disadvantaged contexts.

Teachers are encouraged to prioritize student-centred, flexible teaching strategies that allow learners to explore, observe and express their understanding in different ways. Providing multiple forms of participation, such as drawing, speaking, measuring or using digital tools,

helps ensure that all students, including those with language barriers or lower academic confidence, can actively engage in the learning process.

A gradual progression from simple observation activities towards more structured inquiry and project-based learning is also recommended. This approach supports both teacher confidence and student readiness, especially in classrooms where active learning methodologies may be less familiar.

Collaboration, clear instructions and visual support strategies should be integrated throughout the learning process to reduce barriers and encourage meaningful participation. Simple digital tools may also enhance accessibility, engagement and creativity.

Ultimately, teachers are encouraged to view the local environment as a “living laboratory” that can support interdisciplinary STEM learning, sustainability awareness and inclusive educational practices over the long term.

4.2 Learning Unit 2: Designing Inclusive STEM Learning Activities through Environmental-Based Learning

Introduction

This learning unit focuses on supporting educators in designing inclusive STEM learning activities through the integration of Environment-Based Learning (EBL), with particular emphasis on disadvantaged school contexts. Within the ECOTEACH project, this unit plays a key role in bridging theoretical approaches to inclusive education with practical teaching strategies that can be applied in real classroom environments.

In many disadvantaged schools, students face multiple barriers to learning, including limited prior knowledge, language difficulties, low motivation, and reduced access to supportive learning resources. As a result, traditional teaching approaches in Science and Mathematics may not effectively engage all learners or ensure equal participation. This learning unit addresses these challenges by providing teachers with adaptable frameworks and methodologies that promote inclusion, accessibility, and active engagement.

By integrating environmental contexts into STEM education, the unit supports teachers in creating meaningful and relevant learning experiences that connect scientific and mathematical concepts to real-world situations. Through approaches such as Universal Design for Learning (UDL), differentiated instruction, inquiry-based learning, and socio-emotional learning, educators are guided in redesigning their teaching practices to better respond to diverse student needs.

Overall, this unit contributes to the ECOTEACH project by equipping teachers with the knowledge and practical tools needed to implement inclusive, flexible, and engaging STEM learning experiences, particularly in educational settings where supporting disadvantaged learners is a priority.

Theoretical foundations

This learning unit is grounded in a set of complementary pedagogical approaches that support inclusive and effective STEM education through Environment-Based Learning (EBL), particularly in disadvantaged school contexts.

At its core, Environment-Based Learning (EBL) connects learning to real-world environmental contexts, allowing students to explore scientific and mathematical concepts through meaningful and familiar situations. This approach is particularly valuable in disadvantaged settings, where students may struggle with abstract content and benefit from concrete, context-based learning experiences that enhance relevance and motivation.

Inquiry-Based Learning plays a central role in this unit by encouraging students to actively engage in questioning, investigation, and problem-solving. Through inquiry processes, learners develop critical thinking and scientific reasoning skills, while also becoming more actively involved in the learning process. When applied to environmental challenges, inquiry-based learning enables students to explore authentic issues and develop practical solutions.

In addition, experiential learning supports learning through direct experience, observation, and reflection. This approach allows students to engage with their local environment, making learning more accessible and meaningful, especially for those with limited prior knowledge or academic confidence.

The unit also draws on key principles of inclusive education, particularly through the application of Universal Design for Learning (UDL) and differentiated instruction. These approaches ensure that learning activities are accessible to all students by providing multiple ways of engagement, representation, and expression. In disadvantaged classrooms, where learners may have diverse needs, language barriers, or varying levels of readiness, these strategies are essential for ensuring participation and equity.

Finally, STEM pedagogy is integrated in an interdisciplinary manner, promoting connections between science, mathematics, and environmental topics. By situating STEM learning within real-world environmental contexts, students are supported in developing not only subject-specific competences but also transversal skills such as problem-solving, collaboration, and critical thinking.

Overall, these theoretical foundations support the development of inclusive, engaging, and context-based STEM learning experiences, enabling teachers to design learning environments that respond effectively to the needs of disadvantaged learners while strengthening their understanding of science and mathematics.

Pedagogical approach

The pedagogical approach of this learning unit is based on student-centred, flexible, and inclusive teaching methodologies that support active participation and engagement, particularly in disadvantaged school contexts.

A key approach is inquiry-based learning, where students are encouraged to explore environmental issues through questioning, investigation, and reflection. This approach supports the development of scientific thinking and allows students to engage actively in the learning process. In disadvantaged classrooms, inquiry-based activities can increase motivation by giving students a more active and meaningful role.

Project-based learning further enhances engagement by allowing students to work on real-world environmental challenges over a longer period of time. Through projects, students can apply scientific and mathematical concepts in authentic contexts, while developing problem-solving and collaboration skills. This approach is particularly effective for students who may struggle with traditional instruction, as it provides purpose and relevance to learning.

Collaborative learning is essential for promoting inclusion. By working in mixed-ability groups, students can support each other and contribute based on their individual strengths. This approach helps reduce barriers for students with lower academic performance, language difficulties, or limited confidence, ensuring that all learners can participate meaningfully.

Where possible, outdoor learning can be integrated to connect students directly with their local environment. Activities such as observing, measuring, and recording environmental data provide hands-on experiences that support understanding, especially for students who benefit from experiential learning. In cases where outdoor learning is not feasible, classroom-based simulations and local case studies can provide similar opportunities.

In addition, digital-supported learning can enhance accessibility and engagement. Digital tools can be used for data collection, visualisation, and collaboration, offering alternative ways for students to access and present information. This is particularly useful for students with diverse learning needs, as it allows for multiple forms of expression.

To ensure inclusive participation, teachers should integrate:

- differentiated tasks with varying levels of complexity,
- clear and simplified instructions supported by visuals,
- multiple ways for students to demonstrate understanding,
- scaffolding strategies to support learners with additional needs.

Overall, these methodologies enable teachers to create flexible learning environments that support diverse learners, promote active engagement, and facilitate the development of STEM competences through meaningful environmental contexts. Furthermore, the unit promotes 'Frugal Innovation' in STEM. Instead of expensive laboratory kits, teachers are trained to use everyday recyclable materials and the natural school environment. This ensures that socio-economic constraints of the school district do not limit the quality of scientific inquiry, making STEM accessible to all students regardless of their background.

Practical application in schools

Teachers can apply the concepts of this unit through structured, flexible, and context-based activities that promote inclusion and active participation in STEM learning, particularly in disadvantaged school environments. A practical way to implement these approaches is to organise learning activities in three interconnected phases: observation, analysis, and action, allowing all students to engage progressively and according to their abilities.

→ Phase 1: Environmental observation

Teachers can begin with simple observation tasks based on the immediate school environment. For example, students may observe and record data related to waste production, water usage, or temperature changes within the classroom or school. At this stage, it is important that teachers provide clear, simple instructions supported by visual prompts, ensuring that all students, including those with language difficulties or limited prior knowledge, can participate.

→ Phase 2: Data collection and analysis

Students then collect, organise, and represent data using tables, charts, or visual formats. To support inclusive participation, tasks should be differentiated:

- Some students focus on basic recording, classification, or visual representation of data.
- others engage in more advanced analysis, comparison, or interpretation.

This approach allows mixed-ability groups to work on the same activity while participating at different levels, ensuring that all learners are actively involved.

→ Phase 3: Interpretation and action

Students discuss their findings and propose solutions to real environmental challenges, such as reducing waste or saving energy within the school. Teachers guide this process through structured questions and support students in expressing their ideas through multiple formats (oral, visual, or digital), depending on their strengths.

Teachers can extend these activities to local environmental projects, such as developing a classroom recycling plan, creating awareness materials, or presenting the results to the school community. These projects foster collaboration, responsibility, and problem-solving skills, while also increasing motivation through their real-world relevance.

To effectively support students from disadvantaged backgrounds, teachers should:

- assign clear and differentiated roles within group work (e.g. observer, recorder, organiser, presenter),
- provide visual aids and simplified instructions for students with language or learning difficulties,
- use hands-on materials to support understanding,
- allow multiple ways of presenting results (oral, visual, digital).

Additionally, interdisciplinary STEM activities can be developed by combining science, mathematics, and environmental topics. For instance, students may calculate average water usage (mathematics), analyse environmental impact (science), and propose solutions (problem-solving and critical thinking).

Where available, digital tools can further support inclusion by enabling students to collect, visualise, and present data in accessible ways. Simple tools such as spreadsheets or basic data visualisation applications can enhance engagement, particularly for students who benefit from interactive and visual learning.

Example of classroom application: The "30-Minute Neighborhood Bio-Blitz"

A teacher in a disadvantaged school context can implement a "Bio-Blitz" activity with zero financial cost. In Phase 1, students spend 20 minutes in the schoolyard or the immediate neighborhood street, using a simple checklist to record "Signs of Nature" (e.g., insects, birds, weeds) versus "Signs of Human Impact" (e.g., litter, pavement, noise).

In Phase 2, students return to the classroom to organize their findings. To ensure inclusion, the teacher differentiates the roles:

- Students with language barriers or lower confidence focus on counting and sorting the physical tallies.
- Other students create visual bar charts or pictograms to represent the ratio of nature vs. human impact.
- Advanced learners calculate percentages or compare data between different spots (e.g., "shaded area" vs. "sunny area").

In Phase 3, the class discusses how STEM can help improve their local environment (e.g., "Where could we plant a small tree to increase biodiversity?"). This activity requires no prior knowledge, uses the neighborhood as a "living lab," and transforms students from passive learners into active "Citizen Scientists."

Conclusions and recommendations

The implementation of inclusive STEM learning through Environment-Based Learning (EBL) requires intentional planning, flexibility, and a strong focus on the diverse needs of learners, particularly in disadvantaged school contexts. This learning unit highlights the importance of combining inclusive pedagogical frameworks with practical, real-world learning approaches. By integrating principles such as Universal Design for Learning (UDL), differentiated instruction, inquiry-based learning, and socio-emotional learning, teachers can create learning environments that support participation, engagement, and achievement for all students.

To effectively apply this approach, teachers are encouraged to focus on the following practical strategies and "Quick Wins":

- Prioritize "Resource-Light" Activities: Focus on "frugal innovation" by using recycled materials and the local schoolyard to ensure that financial constraints do not limit inclusivity.
- Design Flexible Entry Points: Create activities that allow multiple ways of participation, ensuring that students with different academic levels can achieve immediate success.
- Promote Empowerment through Role-Playing: Assign clear roles within groups, such as "*Lead Scientist*" or "*Data Journalist*", to build self-efficacy in students with low academic confidence.
- Language & Visual Scaffolding: Use visual aids and hands-on demonstrations to support students with language barriers or limited prior knowledge.
- Use Local Relevance: Connect STEM topics to the immediate challenges of the students' community to make learning more relevant and meaningful.

Particular attention should be given to students from disadvantaged backgrounds. In these cases, teachers should prioritise supportive and motivating learning environments that value student participation and gradual progress.

Finally, it is recommended that teachers continuously reflect on and adapt their teaching practices, ensuring that learning activities remain accessible and responsive to students' needs. Through this approach, EBL serves as a powerful tool for promoting equity and high-quality STEM education for all.

4.3 Learning Unit 3: Integrating Mathematics and STEM Content into EBL

Introduction

Learning Unit 3 focuses on the integration of Mathematics and STEM subjects within the Environment-Based Learning (EBL) framework. The unit demonstrates how mathematical concepts can become more meaningful and accessible when connected to real environmental situations and students' everyday experiences.

Within the ECOTEACH project, this unit supports teachers in linking Science, Mathematics, and environmental education through interdisciplinary learning approaches. It particularly aims to support disadvantaged learners by connecting STEM learning with familiar contexts, practical activities, and collaborative problem-solving.

By using local environmental challenges as learning opportunities, the unit encourages active participation, critical thinking, and data literacy. It also helps teachers create more inclusive STEM learning environments where students can engage with mathematical and scientific concepts through observation, experimentation, and real-life applications.

Theoretical foundations

The theoretical framework of this learning unit is based on interdisciplinary STEM pedagogy, Environment-Based Learning (EBL), and inclusive educational approaches. The main objective is to connect scientific and mathematical concepts with real-world environmental contexts in ways that are meaningful and accessible for all learners.

- Environment-Based Learning (EBL) and Experiential Learning

EBL encourages students to learn through direct interaction with their environment. By using the schoolyard, local neighborhood, or everyday environmental issues as learning resources, students can better understand scientific and mathematical concepts through observation and experience.

Experiential learning approaches support active participation and help students move from concrete experiences toward conceptual understanding. This is especially important for students who may struggle with abstract or highly theoretical instruction.

- Inquiry-Based Learning and STEM Pedagogy

Inquiry-Based Learning (IBL) supports investigation, questioning, and problem-solving. In this unit, students explore environmental issues, collect data, and apply mathematical reasoning to interpret findings.

STEM integration allows students to combine Science, Mathematics, Technology, and environmental awareness through interdisciplinary activities. Mathematics becomes a practical tool for analyzing information, identifying patterns, and proposing solutions.

- Inclusive Education and Data Literacy

Inclusive education principles and Universal Design for Learning (UDL) approaches support differentiated participation and accessibility. Students are encouraged to engage with STEM learning through multiple forms of participation, including observation, measurement, discussion, visual representation, and digital tools.

The unit also promotes basic data literacy skills such as data collection, interpretation, and communication. These competences help students better understand environmental challenges while strengthening critical thinking and collaborative learning.

Through these approaches, the environment becomes a meaningful context for developing STEM competences in an inclusive and student-centered way.

Pedagogical approach

The pedagogical approach of this unit is based on active participation, inquiry, collaboration, and real-world problem solving. The methodologies presented aim to support inclusive STEM learning experiences, particularly in disadvantaged educational contexts.

- Inquiry-Based and Project-Based Learning

Teachers are encouraged to introduce learning through environmental questions or local challenges. Students investigate problems, collect information, and use mathematics and science concepts to interpret their findings. Project-based activities help students connect STEM learning with practical situations while increasing engagement and motivation.

- Outdoor and Experiential Learning

Outdoor learning activities allow students to observe, measure, and analyze elements of their immediate environment. These experiences help students connect abstract concepts with concrete situations and support participation through hands-on learning.

- Collaborative Learning

Collaborative group work supports communication, peer learning, and inclusive participation. Teachers may assign different roles within groups (e.g., data recorder, presenter, observer, researcher) so that students can contribute according to their strengths and interests.

- Digital-Supported Learning

Simple digital tools such as spreadsheets, graphing tools, or smartphone applications can support data collection and visualization. Digital resources also increase accessibility and help students better interpret and present their findings.

- Low-Cost and Accessible STEM Approaches

The unit encourages the use of low-cost or recycled materials to ensure that all schools can implement the activities regardless of available resources. Everyday materials and local environmental observations can become valuable STEM learning opportunities.

By combining these methodologies, teachers can create flexible and inclusive learning environments where students actively engage with Science and Mathematics through environmental contexts.

Practical application in schools

Teachers can apply the concepts of this unit by transforming the school environment into a practical learning space where students investigate real-world environmental situations.

The implementation follows a structured, three-phase pedagogical cycle:

- Phase 1: Environmental Observation & Data Collection: Collaborative teams collect raw data directly from their surroundings, grounding STEM concepts in their physical reality.
- Phase 2: Data Analysis & Inclusive Modeling: Students process their data in the classroom. Teachers use visual and tactile methods (e.g., "Physical Graphs" where students stand in lines or arrange recycled items) to ensure concepts like averages and ratios are understood before moving to formal symbols.
- Phase 3: Interdisciplinary STEM Action: Students apply their mathematical and scientific findings to design and propose small-scale sustainability solutions.

Example Activities

1. Energy and Water Investigation

Students analyze school energy or water consumption by observing daily use patterns and collecting simple data.

- *Mathematics:* Averages, percentages, and basic data analysis.
- *Science:* Energy efficiency and the water cycle.
- *Technology:* Digital graphs and charts.
- *Environmental Education:* Sustainability awareness.

Students work in groups to identify areas of waste and propose realistic sustainability solutions for the school environment.

2. Geometric Garden Activity

Students design a small garden area using measurements and geometric calculations. Possible learning outcomes include:

- Calculating perimeter and area.
- Estimating quantities of soil or seeds using basic volume calculations and ratios.

- Understanding spatial organization.
- Connecting mathematics with environmental planning.

3. Noise and Light Observation

Using simple observation tools or free smartphone applications, students collect data related to noise or light levels around the school. Students organize the information using tables, graphs, or visual representations and discuss possible environmental impacts.

Example Interdisciplinary Classroom Scenarios

Scenario 1 – “School Water Consumption Investigation”

- Subjects involved:
 - *Mathematics* $\rightarrow$ Data analysis, calculating arithmetic means, and percentages.
 - *Science* $\rightarrow$ Water cycle and water flow and consumption patterns.
 - *Technology* $\rightarrow$ Digital graphing tools or spreadsheet software.
 - *Environmental Education* $\rightarrow$ Responsible water use and conservation.

- Description:

Students collect water usage data from school facilities or utility bills. In the classroom, they create graphs, calculate the **mean average consumption per student**, and use **ratios** to estimate potential water savings if low-flow taps were installed. They finish by discussing ways to reduce water waste in the school environment. This activity supports interdisciplinary STEM learning while promoting environmental awareness, collaboration, and problem-solving.

Scenario 2 – “Schoolyard Biodiversity Mapping”

- Subjects involved:
 - *Mathematics* $\rightarrow$ Counting, classification, spatial geometry, and introductory statistics.
 - *Science* $\rightarrow$ Ecosystems, plant biology, and local biodiversity.

- *Technology* → Digital photography, smartphone apps, or basic mapping tools.
- *Environmental Education* → Local biodiversity awareness and habitat protection.

- Description:

Students observe and record different plant species, insects, or natural elements found in designated quadrants of the schoolyard. They organize the collected data into tables or **bar graphs**, compare findings across different zones (**such as calculating the range between high-traffic asphalt and quiet green spaces**), and discuss factors affecting biodiversity. Students can also use basic geometry to create scale biodiversity maps or visual presentations using digital tools or hand-drawn, recycled materials. This activity promotes observation skills, scientific inquiry, teamwork, and environmental awareness while helping students connect STEM learning with their immediate surroundings.

Conclusions and recommendations

Environment-Based Learning can make Science and Mathematics more meaningful, accessible, and engaging for disadvantaged learners when connected with real-life environmental situations.

To support successful implementation, teachers are encouraged to:

- Begin with simple and familiar environmental contexts to reduce learning anxiety.
- Prioritize active participation, communication, and peer collaboration.
- Provide visual and practical learning opportunities through tactile and physical data modeling.
- Use differentiated teaching strategies by assigning distinct student roles within groups.
- Integrate low-cost, recycled, and accessible materials to eliminate resource barriers.
- Support students in connecting STEM learning with their daily lives and local communities.

Teachers are also encouraged to remain reflective and adaptive, tailoring activities according to the specific cultural, social, and academic profiles of their students. Through this inclusive and interdisciplinary approach, students can strengthen STEM competences, environmental awareness, and collaborative problem-solving skills in highly accessible ways.

4.4 Learning Unit 4: Digital Tools and Resources for Enhancing EBL in STEM

Introduction

Learning Unit 4 focuses on the role of digital tools and technological resources in enhancing Environment-Based Learning (EBL) within Science and Mathematics education. In the context of the ECOTEACH project, this unit aims to support teachers in integrating accessible and practical digital solutions into their teaching practices, particularly in disadvantaged school environments.

In many educational settings, especially those with limited resources, digital tools can act as powerful enablers of engagement, inclusion, and real-time learning. When combined with environmental observation and STEM education, technology allows students to collect, analyse, and visualise data in ways that make learning more interactive and meaningful.

This unit provides teachers with guidance on how to use digital tools not as an end in themselves, but as a means to facilitate inquiry, collaboration, and problem-solving. By connecting digital technologies with real environmental contexts, educators can create learning experiences that are more engaging, inclusive, and aligned with the digital competences required in today's society.

Theoretical foundations

The theoretical foundation of this unit is based on the integration of digital pedagogy, Environment-Based Learning (EBL), and STEM education, with a strong focus on accessibility and inclusion.

Environment-Based Learning provides the contextual framework, where students explore scientific and mathematical concepts through real environmental situations. Digital tools enhance this process by enabling more accurate observation, data collection, and analysis, transforming the environment into a dynamic and interactive learning space.

Inquiry-Based Learning plays a central role, as digital technologies allow students to investigate environmental questions through data-driven processes. Tools such as sensors, mobile applications, or simple data collection platforms support students in acting as active learners, rather than passive recipients of information.

Experiential learning is also reinforced through the use of digital resources. For example, students can document environmental observations using mobile devices, create visual representations of data, or simulate environmental processes using digital platforms. These

experiences make abstract concepts more tangible, especially for learners with limited prior academic knowledge.

From an inclusion perspective, digital pedagogy offers multiple entry points for learning. Through visualisation tools, interactive applications, and multimedia resources, students with diverse learning needs, including those with language barriers or low academic confidence, can access content in more flexible and engaging ways.

Finally, the use of open educational resources (OER) supports accessibility and sustainability, ensuring that teachers can implement digital-supported EBL without requiring expensive equipment or specialised infrastructure.

Pedagogical approach

The pedagogical approach of this unit is based on the meaningful integration of digital tools into student-centred and inquiry-based learning environments.

A key strategy is the combination of inquiry-based learning and digital-supported learning, where students use digital tools to explore environmental questions. For example, they may collect environmental data (temperature, noise, light levels) using simple mobile applications and analyse the results using basic digital tools such as spreadsheets or visualisation platforms.

Examples of free and accessible digital tools include Google Sheets for environmental data analysis, Google My Maps for mapping local environmental observations, iNaturalist for biodiversity monitoring, and NASA Climate Kids resources for environmental awareness activities. These tools require minimal technical expertise and can be easily integrated into STEM learning activities.

Project-based learning is also central to this unit. Students can work on environmental challenges, such as analysing pollution levels or monitoring biodiversity, using digital tools to support each phase of the project: data collection, analysis, and presentation.

Collaborative learning is enhanced through digital technologies, allowing students to share data, co-create content, and present findings using digital formats. This is particularly beneficial in disadvantaged classrooms, where collaboration can support peer learning and reduce individual barriers.

Digital storytelling and visualisation are especially important in this unit. Students can transform data into visual formats (charts, infographics, simple videos), making learning more accessible and engaging. This approach supports students who may struggle with traditional text-based learning by offering alternative ways of understanding and expressing knowledge.

Importantly, the unit promotes a 'low-threshold digital approach', encouraging the use of simple, free, and widely available tools. This ensures that the integration of technology does not create new inequalities but instead supports inclusive participation.

Practical application in schools

Teachers can apply the concepts of this unit by integrating digital tools into environment-based STEM activities through a simple and flexible three-step approach: observe, analyse, and communicate.

In the first phase, students use digital tools to observe and collect environmental data. For example, they may use smartphones to measure noise levels, light intensity, or temperature in different areas of the school. These activities require minimal resources and can be easily adapted to different contexts.

In the second phase, students analyse the collected data using accessible digital tools such as spreadsheets or simple data visualisation platforms. Teachers can support inclusive participation by assigning different roles within groups, ensuring that all students contribute according to their abilities.

In the third phase, students communicate their findings using digital formats. This may include creating charts, presentations, or short videos explaining their results and proposing solutions to environmental challenges.

Practical examples include:

- Conducting a 'Digital Environmental Audit' of the school using mobile apps
- Creating visual dashboards to represent environmental data
- Developing simple digital stories about local environmental issues
- Using open-access platforms to explore environmental datasets
- Using freely available tools such as Google My Maps or iNaturalist to document local biodiversity and environmental observations.

These activities help students connect scientific and mathematical concepts with real-world applications while developing digital competences and collaborative skills.

Conclusions and recommendations

To effectively implement digital tools in Environment-Based Learning, teachers should prioritise simplicity, accessibility, and pedagogical purpose over technological complexity.

Digital tools should be used to enhance learning processes, not to replace them. Teachers are encouraged to start with simple tools that are already available, such as smartphones or basic software, and gradually expand their use as confidence increases.

It is important to ensure that all students can participate, regardless of their digital skills or access to technology. Providing clear instructions, using visual supports, and encouraging collaborative work can help reduce barriers and promote inclusion.

Teachers should also focus on connecting digital activities with real environmental contexts, ensuring that technology supports meaningful and relevant learning experiences.

When working in schools with limited connectivity or restricted access to devices, teachers should prioritise low-bandwidth solutions, offline resources, and collaborative group work that allows students to share available technology. The educational value of digital tools lies in their pedagogical use rather than in technological complexity.

Finally, by integrating digital tools into EBL, educators can help students develop not only STEM competences but also digital literacy, critical thinking, and problem-solving skills, preparing them to actively engage with environmental and societal challenges.



4.5 Learning Unit 5: Community Engagement and Project-Based Learning in EBL

Introduction

Learning Unit 5 focuses on the role of community engagement and project-based learning (PBL) in strengthening Environment-Based Learning (EBL) within Science and Mathematics education. In the context of the ECOTEACH project, this unit aims to support teachers in connecting classroom learning with real environmental challenges through active collaboration with local communities.

For many students, especially those in disadvantaged school contexts, traditional classroom-based learning can feel disconnected from their daily lives. This unit addresses that gap by promoting learning experiences that extend beyond the classroom, encouraging students to engage with their local environment, community actors, and real sustainability challenges.

Through project-based learning and community involvement, students are not only exposed to STEM concepts but also encouraged to apply them in meaningful and socially relevant ways. This approach helps increase motivation, develop a sense of responsibility, and foster a stronger connection between learning and real-world impact.

Ultimately, this unit provides teachers with practical guidance to design learning experiences where students become active participants in their communities, using science and mathematics as tools to understand and improve their environment.

Theoretical foundations

The theoretical basis of this unit is grounded in the integration of Environment-Based Learning (EBL), Project-Based Learning (PBL), and community-based education, with a strong emphasis on inclusion and real-world relevance.

Environment-Based Learning provides the framework for connecting STEM education with local environmental contexts. By using the surrounding environment as a learning space, students can explore scientific and mathematical concepts through direct observation and real-life situations.

Project-Based Learning plays a central role by structuring learning around real-world problems that require investigation, collaboration, and solution development. In this unit, environmental challenges, such as waste management, energy use, or local biodiversity, serve as the starting point for student projects.

Experiential learning supports this approach by emphasising learning through action, reflection, and participation. Students engage with their environment and community, making learning more meaningful, especially for those who may struggle with abstract or theoretical content.

Community-based learning further strengthens the educational process by involving local stakeholders such as environmental organisations, municipalities, or community groups. This connection allows students to see the real impact of their work and reinforces the relevance of STEM learning.

From an inclusion perspective, these approaches are particularly valuable in disadvantaged contexts. By focusing on real-world issues and collaborative activities, they provide multiple entry points for participation, allowing students with different abilities, backgrounds, and levels of confidence to engage meaningfully in the learning process.

Pedagogical approach

The pedagogical approach of this unit is based on active, student-centred learning, where students take a leading role in exploring environmental challenges and developing solutions through collaborative projects.

Project-based learning is the core methodology. Teachers guide students in identifying a local environmental issue and developing a project that includes investigation, data collection, analysis, and proposal of solutions. This approach supports the development of both STEM competences and transversal skills such as teamwork, communication, and problem-solving.

Collaborative learning is essential to ensure inclusive participation. Students work in groups with clearly defined roles, allowing each learner to contribute according to their strengths. This is particularly important in disadvantaged classrooms, where differentiated participation can help reduce barriers and increase engagement.

Community engagement is integrated into the learning process by connecting students with local actors. This may include interviews with community members, collaboration with environmental organisations, or participation in local initiatives. These interactions provide authentic learning experiences and help students understand the real-world implications of their work.

Inquiry-based learning also plays an important role, as students investigate environmental issues, formulate questions, and explore possible solutions. Teachers act as facilitators, supporting students throughout the process and encouraging reflection and critical thinking.

Finally, the approach promotes flexibility and adaptability, allowing teachers to design projects that fit their specific context, resources, and student needs.

Practical application in schools

Teachers can implement this unit by organising learning activities around real environmental projects connected to the local community, following a structured but flexible process.

A practical approach can be organised in three phases: explore, develop, and act.

In the first phase, students explore their local environment and identify relevant issues. This may include observing waste management practices, analysing green spaces, or identifying environmental challenges within the school or neighbourhood.

In the second phase, students develop their projects. They collect data, analyse information, and work collaboratively to propose solutions. Teachers can support inclusive participation by assigning roles such as researcher, organiser, communicator, or designer.

In the final phase, students take action by presenting their findings or implementing small-scale solutions. This may include awareness campaigns, presentations to the school community, or collaboration with local organisations.

Practical examples include:

- Designing a school recycling or waste reduction project
- Collaborating with a local environmental organisation on a community initiative
- Creating awareness campaigns on sustainability issues
- Developing small-scale environmental improvement proposals for the school or neighbourhood

Example of practice:

A school may collaborate with the local municipality or an environmental association to analyse waste generation within the community. Students can collect and classify waste data, calculate recycling rates, identify improvement opportunities, and present their findings to local stakeholders. This type of project combines environmental awareness, mathematics, scientific inquiry, and civic participation while creating a tangible impact on the local community.

These activities help students connect STEM learning with real-life applications while developing a sense of responsibility and active citizenship.

Conclusions and recommendations

To successfully implement community-based and project-based learning, teachers should focus on relevance, participation, and flexibility.

Projects should be based on real and meaningful environmental issues that students can relate to in their daily lives. This increases motivation and helps students understand the value of their learning.

Teachers are encouraged to design activities that allow for different levels of participation, ensuring that all students can contribute regardless of their academic level or background. Assigning clear roles within group work can support inclusion and build confidence.

It is also important to keep projects manageable and adaptable to available resources. Even small-scale initiatives can have a strong educational impact if they are well designed and connected to real contexts.

Finally, fostering collaboration with the local community can significantly enhance the learning experience. By interacting with real stakeholders, students gain a deeper understanding of environmental challenges and develop the skills needed to participate actively in society.

Through this approach, Environment-Based Learning becomes not only a pedagogical method, but also a tool for empowering students and strengthening the connection between education, community, and sustainability.

4.6 Learning Unit 6: Assessment and Impact Evaluation of EBL in Disadvantaged Contexts

Introduction

Unit 6 is the final learning unit of the ECOTEACH programme. It focuses on assessment and evaluation and is designed to help teachers to review how well the previous units have worked in practice.

The unit covers formative and summative assessment methods, the assessment of STEM competences, and ways to measure student engagement and motivation. It also supports reflective teaching and the monitoring of learning outcomes in disadvantaged school contexts.

Effective Environment-Based Learning (EBL) is not just about designing and delivering good learning experiences. Teachers also need to be able to assess whether those experiences are building STEM competences, and to evaluate the broader impact on their learners.

This matters most for students in disadvantaged contexts. Environmental and socio-economic factors can strongly affect motivation, participation, and outcomes. Unit 6 equips teachers to recognise and respond to these factors in their assessment practice.

Ultimately, this unit aims to help teachers take a reflective, confident approach to their own practice. By learning to evaluate EBL approaches and share findings with stakeholders, teachers become active contributors to improving STEM education for disadvantaged students.

Theoretical foundations

Assessment and impact evaluation are central to any successful school initiative. They provide the evidence needed to make good decisions about teaching, learning, and resources. For schools working with disadvantaged students, this is especially important, as the consequences of ineffective teaching can be significant and resources need to be carefully directed.

A key concept in this space is the difference between formative and summative assessment. Formative assessment (sometimes called Assessment FOR Learning or AfL) is low-stakes, ongoing, and focused on feedback rather than grades. Research consistently shows it has a strong positive impact on lower-attaining students.

Through EBL activities such as observation, questioning, peer discussion, reflective journaling, and experimentation, formative assessment allows teachers to gather meaningful information about students' developing STEM abilities and adjust their teaching accordingly. Competence-based assessment is another key foundation for this area. Rather than testing the recall of facts, it focuses on how students apply knowledge and skills in real, meaningful situations. This fits well with the inquiry-driven nature of EBL, where students observe, analyse, investigate, and draw conclusions from their natural environment.

Competence-based assessment also supports a shift from lower-order thinking skills (such as "Remember" and "Understand" in Bloom's Taxonomy) towards higher-order skills such as "Analysis" and "Evaluation".

Kirkpatrick's Four-Level Model of evaluation provides a structured way to assess the effectiveness of educational programmes. It covers four levels: Reaction, Learning, Behaviour, and Results. This is particularly useful for EBL, as it captures not just learning outcomes but also student engagement and changes in behaviour, which are important considerations for disadvantaged learners who may not perform well in traditional assessment settings.

Additional frameworks in this area include Vygotsky's Zone of Proximal Development (ZPD) and Schön's concepts of reflective practice, outlined later in this unit.

Pedagogical approach

Formative Assessment / Assessment FOR Learning (AfL)

EBL is built on practical, hands-on learning. Assessment FOR Learning (AfL) fits this approach well. It is low-stakes, active, and focused on learning rather than scores.

Teachers can apply AfL through structured tools such as observation checklists, questioning frameworks, and assessment activities designed around student observation, reflection, and experimentation. These strategies can be used directly in the classroom and reinforce the idea that meaningful learning comes from doing, not just listening.

This approach is particularly relevant for disadvantaged students, for whom high-pressure assessment can be a barrier to engagement.

Zone of Proximal Development

Vygotsky's concept of the Zone of Proximal Development (ZPD) highlights the value of timely, structured support over independent performance or repetitive content delivery.

In practice, this means designing assessment activities that are scaffolded and collaborative, and that are sensitive to the social and cultural contexts of learners. This is especially relevant in EBL, which draws on students' own environments and experiences. It is also important for

students whose engagement with formal education has been shaped by socio-economic disadvantage.

Reflective Practice

Schön's concepts of reflection-in-action (reflecting during a task) and reflection-on-action (reflecting after a task) are central to EBL for STEM.

Encouraging students to reflect while completing investigative tasks helps them question their own thinking in real time, rather than simply recording results. This builds genuine scientific and mathematical reasoning.

Follow-up activities such as learning journals, peer discussions, and guided prompts give students the opportunity to revisit and consolidate their learning, deepening their understanding of EBL experiences.

Kirkpatrick's Four-Level Model

Kirkpatrick's model is recommended as a practical framework for programme evaluation. It helps teachers to examine impact at multiple levels — from how learners felt about the programme, to what they learned, how they changed their behaviour, and what results were achieved.

This approach frames evaluation as a process of understanding and improvement, rather than a judgement of success or failure. It also connects well to the sustainability and environmental aims of EBL.

Practical application in schools

The assessment and evaluation approaches in this unit have been designed to sit naturally within EBL practice. Rather than treating assessment as an administrative task, the aim is to make it tangible and purposeful, directly connected to teachers' everyday experiences of delivering EBL for STEM.

The key principle is to embed formative assessment and evaluation within the EBL teaching process itself, not to add them on as an afterthought or treat them as separate activities.

Assessment FOR Learning (AfL)

Assessment FOR Learning (AfL) is well suited to the hands-on, inquiry-based nature of EBL. It is low-stakes, learning-focused, and prioritises feedback over marks or scores.

In practice, this means creating an open and supportive environment where students feel safe to take risks, make mistakes, and learn from them. The focus should be on understanding rather than grades.

This is particularly important for disadvantaged students, for whom high-stakes assessment can be an additional barrier to engaging with science and mathematics. Useful AfL tools within EBL include observation checklists, questioning frameworks, and assessment activities built around student observation, reflection, and experimentation.

Zone of Proximal Development

Vygotsky's Zone of Proximal Development (ZPD) supports the use of scaffolded, collaborative assessment. Rather than measuring what students can do independently, this approach involves designing activities that offer timely, structured support, from the teacher or from peers, enabling students to demonstrate and extend their competences.

This is especially relevant in EBL, where learning is grounded in students' own environments and lived experiences. Assessment designed with sensitivity to students' social, cultural, and socio-economic contexts ensures that all learners, including those whose engagement with formal education has been shaped by disadvantage, can participate meaningfully.

Reflective Practice

Drawing on Schön's reflective practice approach, students should be actively encouraged to reflect during investigative tasks. This helps them to examine their own observations and reasoning in real time, fostering authentic scientific and mathematical thinking.

Follow-on activities such as learning journals, peer discussion, and guided prompts give students the opportunity to revisit and consolidate their learning afterwards. Reflection is flexible enough to be built into most activities without placing heavy demands on literacy or formal writing skills, making it a practical and inclusive tool.

Kirkpatrick's Four-Level Model

Kirkpatrick's model provides a practical framework for programme evaluation through data-gathering across up to four levels. It is not necessary to address all four levels; teachers should work with whichever levels are most feasible for their context.

The four levels are:

- Level 1 – Reaction: How did learners feel about the programme overall?
- Level 2 – Learning: To what extent were the intended learning outcomes achieved?
- Level 3 – Behaviour: Were learners able to apply what they learned in their day-to-day activities?
- Level 4 – Results: How well did the programme meet its broader goals?

Data can be gathered in whatever way best suits the target audience. A focus group with students involved in EBL is identified as a particularly effective approach.

Conclusions and recommendations

The most important overall recommendation for teachers is to treat assessment and evaluation as integral parts of the learning experience, not as separate tasks.

When assessment is embedded naturally within EBL, through observation, questioning, peer discussion, and experimentation, it becomes a seamless part of the learning journey. Keeping it low-stakes, learning-focused, and dialogue-based creates an environment where students feel safe to engage openly and demonstrate their understanding.

Teachers are encouraged to use scaffolded, collaborative approaches informed by Vygotsky's ZPD. Practical tools such as observation checklists, questioning frameworks, and guided reflection prompts can be adapted to suit a wide range of learners and EBL contexts.

Embedding reflection into EBL activities is both accessible and highly effective. Encouraging students to pause and reflect during tasks, and to revisit their thinking through journals or group discussions afterwards, deepens STEM reasoning. Reflection can be built into most activities without requiring strong literacy skills, making it particularly useful for inclusive practice.

Finally, teachers are encouraged to use Kirkpatrick's Four-Level Model for programme evaluation, gathering evidence at whichever levels are most feasible. Even a simple focus group or student feedback activity can provide valuable insights, helping teachers to refine their practice and build a meaningful evidence base for students, schools, and wider stakeholders.

5. Final Remarks

The ECOTEACH Conceptual and Pedagogical Framework provides a common foundation for translating the project's Learning Outcomes into inclusive, practical and adaptable Environment-Based STEM education. Across the six Learning Units, the Framework connects pedagogical principles with active learning, digital approaches, community engagement and assessment, with particular attention to disadvantaged learners and educational contexts.

The Framework should be understood as a flexible reference rather than a prescriptive model. Teachers and educators are encouraged to adapt its approaches to their learners, available resources and local environmental realities. Together with the Electronic Database, Hands-On Exercises, Evaluation Methods and Tools and Online Training Course, it contributes to a coherent ECOTEACH Virtual Classroom in which pedagogy, practice and assessment are closely interconnected.