GREEN CODE

PREPARING FUTURE EDUCATORS

Higher Education Course Curriculum on Robotics and Environmental Education

Funded by the European Union
Valsts izglītības attīstības aģentūra
University of Latvia
University of Mannheim
Politécnico de Viseu
Scuola di Robotica
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Preparing Future Educators: a Higher Education Course Curriculum on Robotics and Environmental Education

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Introduction

The European Commission (EC) developed the European Green Deal Plan to transform the EU into a climate-neutral, circular, and resource-efficient economy, while ensuring a sustainable life (European Commission, 2023). The Green Deal highlights fresh air, clean water, healthy food, longer-lasting products that can be repaired, recycled and reused, cleaner energy and biodiversity. Eco-friendly practices walk in a spirit of partnership, making the right choices today to improve life sustainably for future generations.

Education has an important role to play in that transformation. There are several educational initiatives that contribute to environmental protection and green practices. Early Childhood Education is included in those efforts but the different approaches to Environmental and Sustainability Education vary from more adult-guided proposals to more child-led proposals. Research has shown the relevance and impact of involving children in educational tasks to enable them to support these goals "as practitioners", not only as receivers of information or through token participation. Children's involvement in the problem-solving and decision-making processes and in the identification of the steps of a solution is of critical importance, since they are developing 21st-century skills by being producers rather than just consumers (Taguma et al., 2018). Preschool teachers play an essential role in supporting children to have a growth mindset for striving to discover and create things that will be beneficial for themselves and for the community, starting from the early years (Ljubetić, 2012). Educational robotic applications are one of the ways that can involve children in STEM (Science, technology, engineering, and mathematics) subjects (Tselegkaridis & Sapounidis, 2022). GREENCODE intends to support future Early Childhood Education teachers to use robotics to promote significant learning regarding the environment and sustainability.

Project Overview and Objectives

The "Building an Eco-Friendly Future with Robots" project, also known as GREENCODE, integrates STEM/STEAM education in Early Childhood Education with a strong focus on sustainability and green practices. The project has three main priorities: (1) ensuring that early childhood teacher education institutions are equipped with effective STEM/STEAM teaching strategies, (2) connecting these strategies to environmental protection and green practices, and (3) using educational robotics to provide enjoyable, easy, and engaging learning experiences. By developing and updating the professional skills of preservice preschool teachers in both technology and eco-friendly practices, the project equips them to foster computational thinking and problem-solving skills in young children, ensuring they learn to live in peace, prosperity, and a clean environment from an early age. Through robotics as a tool for interactive learning, the project supports the creation of innovative teaching materials that prepare future teachers to address environmental challenges with engaging, technology-driven methods.

Project Information	
Title	Building an Eco-Friendly Future with Robots
Acronym	GREENCODE
Reference Number	2023-1-LV01-KA220-HED-000157623
Start date	01/09/2023
End date	31/08/2025
Duration	24 months

GREENCODE is funded by the ERASMUS+ programme of the European Union. It is a joint project, carried out by seven project partners from the European Union. The project coordinator is the University of Latvia. The project partners are:

- University of Mannheim, Germany
- Instituto Politécnico de Viseu, Portugal
- University of Rijeka, Croatia
- Scuola Di Robotica, Italy
- Mellis, Turkey
- Early Years, Ireland

The GREENCODE Higher Education Curriculum

The GREENCODE Higher Education Curriculum has been developed to equip preservice preschool teachers and their respective departments in higher education institutions with the necessary skills and training opportunities to teach children in kindergartens and preschools about sustainable and eco-friendly practices, through unplugged coding and robotics applications. The curriculum enhances children's understanding of life cycle thinking and other green practices based on the Inquiry-Based Learning (IBL) approach. The curriculum serves as a comprehensive framework, encompassing objectives, teaching materials, methods, and assessment techniques. It follows a modular structure that includes theoretical explanations. The curriculum can be adapted by education authorities for in-service training of current preschool teachers, allowing for country-specific modifications based on local needs.

This flexible approach ensures that both future and existing teachers are equipped to encourage environmental awareness and digital literacy in young children. The project specifically focuses on preservice preschool teachers, as well as current preschool and ICT teachers, with an emphasis on implementation in targeted countries.

The curriculum is structured into five modules:

Module 1: Inquiry-Based Learning

Module 1 introduces the framework of Inquiry-Based Learning (IBL), which is the theoretical learning approach of the GREENCODE Project. IBL encourages learners' ability to ask questions, experiment, discuss and reflect. In practice, learners should be engaged with their surroundings to promote their interest in a certain topic. As learners investigate these topics, they learn how to ask questions, gather information and compare their knowledge to prior assumptions. This is the basis for the creation of new knowledge, skills and competences. Finally, learners can reflect on their learning experiences and anticipate how they can research fields of interest in the future.

Module 2: Supporting the Implementation of IBL in ECE

Module 2 integrates Inquiry-Based Learning into the realm of Early Childhood Education. Combining IBL with ECE requires special attention to the different phases of the framework, as young children need custom-fit learning designs to accommodate their development prerequisites. Therefore, Module 2 provides best-practice examples and strategies for the education of young children through the IBL cycle.

Module 3: The Importance of Outdoor and Indoor Activities for Environmental Education in ECE

Sustainable eco-friendly practices involve indoor and outdoor activities. Module 3 underlines the necessity to provide learning opportunities both within the indoor and outdoor environments of the educational facilities. Supporting the protection of the world around us can start with the single action of one person in their own home, but it is always embedded into overarching systems. In the sense of IBL, indoor and outdoor activities need to be combined to teach children about these relationships, such as reducing water waste at home and the reprocessing of freshwater in the local purification plant.

Module 4: Basic Hands-on Robotics and Coding Activities

Module 4 introduces educational robotics and the related coding activities for ECE. The GREENCODE Project aims to use these technologies to both foster environmental awareness and computational thinking. Educational robots are a playful method to reach both goals. The examples in the module will help teachers to teach algorithmic basics and show how robots can use these algorithms for environmentally friendly practices, such as rubbish collection, reduction of waste or eco-friendly farming techniques.

Module 5: The Role of Evaluation and Documentation in ECE in the IBL Approach

Module 5 focuses on the ability of teachers to create high quality documentation of the teaching and learning processes. By using words, pictures, photographs, artefacts and similar forms of documentation, teachers ensure that they can guide children through the cycles of the IBL approach. The documentation can be used to legitimise teachers' professional actions in front of other stakeholders, such as families, investors, public institutions, political decision makers and wider society.

Inquiry-Based Learning fosters children's natural curiosity, helps to develop critical thinking, enhances communication skills, promotes independent learning and builds the foundation for lifelong learning. High quality evaluation and documentation is an important part of supporting children throughout their IBL learning journey.

Module 6: Inquiry-Based Learning Approach: a Step-by-Step Guide

Here is an opportunity to get acquainted with the IBL approach step by step sample, which includes examples of the implementation of this approach in Early Childhood Education.

Together, these modules form a robust **methodological framework** that equips preservice teachers with the knowledge and skills necessary to integrate the three topics of robotics, coding and sustainability into their teaching practices from a holistic perspective. The GREENCODE project partners organised consultation workshops in each partner country to invite preschool teachers, administrators and experts to give their views and perspectives on the proposed titles and content of the planned modules.

Ethical Considerations

Using educational robots in the context of Early Childhood Education requires the consideration of multiple ethical fields. Privacy and data security regulations must be upheld to ensure the protection of children's personal information (Singh et al., 2023). Clearly communicating how robots will be used, what data will be collected, and how it will be used and stored is essential to comply with requirements of informed consent from parents or caregivers. Educational robots carry the risk of a lack of equality in accessing the technology. Equity and accessibility need to be ensured to guarantee benefits, independent of socioeconomic status, ethical background or disabilities. In addition, robots should not be seen as possible replacements for humans or other learning methods. While robots have their place in our world, they should not be seen as tools which relieve humans from their own responsibilities. Therefore, a balanced use which encourages self-directed learning and problem-solving should be promoted. The implementation of educational robots must be safe and reliable to prevent children (and teachers) from being harmed both physically and emotionally. Teachers and educators at all levels of Early Childhood Education need adequate competences to maintain these high professional standards, which makes a holistic training approach necessary. As a result, all stakeholders will gain an understanding of the potential broader societal impacts of robots and the consequent changes to ethical and societal norms.

MODULE 1

Inquiry-Based Learning

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This module will offer guidance on the implementation of the Inquiry-Based Learning (IBL) approach in Early Childhood Education. IBL is integral to the GREENCODE project because it emphasizes a learner-driven approach where children actively explore, investigate, and make sense of the world around them. This approach aligns with the developmental needs of preschoolers, who are naturally curious and eager to learn. However, the recommendations made by the teachers during the workshops underlined the importance of maintaining a child-led approach supported by skilled adult support. While educators found IBL to be a valuable approach, they highlighted the need for additional training and further discussion on its implementation within their settings.

Inquiry-Based Learning in Early Childhood Education

The GREENCODE project aims to enhance the skills and training opportunities of preservice preschool teachers, equipping them with the skills to engage children in environmental awareness and future-oriented thinking. To achieve this, Inquiry-Based Learning (IBL) is crucial. IBL encourages curiosity and critical thinking, allowing children to actively explore environmental issues and develop problem-solving skills. By integrating IBL with educational robotics, the project promotes both algorithmic thinking and hands-on engagement, ensuring that children not only gain awareness but also the practical skills needed for lifelong learning and sustainable practices. The integration of Inquiry-Based Learning (IBL) with educational robotics in Early Childhood Education (ECE) offers unique advantages for achieving the project's goal of providing high-quality environmental education and algorithmic thinking skills. IBL encourages young learners to explore, ask questions, and solve problems, while robotics provides a hands-on tool for them to experiment and apply concepts in practice.

Preschool, also known as Early Childhood Education (ECE), is the first step in the education system, laying the foundations for knowledge, skills, competencies and attitudes at all levels of education. Skills such as – asking questions, seeking answers, experimenting, comparing, analysing, discussing, debating, and reflecting - are essential for every child who will live in tomorrow's world. Rapid developments in scientific and technological fields require individuals who have acquired the ability to carry out research. The world today is experiencing a complex set of environmental problems. Global environmental challenges such as climate change affect the whole world manifesting in extreme weather conditions, heat waves, droughts, floods, declining natural productivity, etc. The growing problems such as biodiversity loss and plastic pollution have an increasing impact on people, animals, plants, etc. Recognising that these problems are a challenge for society, requires that these issues be raised in the early years. Children are explorers - they want to explore, question and experiment. The learning process from the preschool years should take these natural traits as a guide to developing exploratory skills. By offering children a variety of activities that allow them to explore the materials and search for answers, they can develop a deeper interest in different topics and a willingness and ability to ask questions. An activity based on exploratory learning fits with IBL which is an educational approach in which, with the active involvement of the student and using methods close to those of professional scientists, students formulate hypotheses, investigate them, discover causal relationships, thereby reaching conclusions and constructing new knowledge (Pedaste et al., 2015). IBL requires that a child moves through a complete cycle of learning in which he or she has the opportunity "to engage in predicting, planning, collecting data, organising experience, and searching for the latest patterns and relationships as well as new problems" (Xunyi et al., 2021).

At the very beginning, the inquiry is initiated and stimulated by a surprising event or problem to be solved, proposed by the teacher based on the children's previous activities and interests. This is followed by a step to identify and understand the concepts to be explored. To identify and explain these concepts, the teacher stimulates the students' thinking by asking questions, hypothesising, inviting opinions. (Zudaire et al., 2022) This is followed by an exploration phase, where students can work on an experiment or project to collect "data" to help answer the questions. Once the data is collected, it needs to be interpreted to answer the questions and confirm or not the hypotheses. According to a study published in 2022, "Mars Explorers: A Science Inquiry-Based Learning Project in Preschool" – "This scientific skill could be hard for preschoolers, due to their limited ability to sort out data and infer patterns or relationships" (Zudaire et al., 2022). It is therefore at this stage that the teacher's ability to make links between the data and the conclusions drawn plays an invaluable role. Successful interpretation of the data is followed by a reflection phase, where conclusions are drawn by reviewing the findings and new knowledge, as well as a potential discussion on further research questions.

Where the phases and activities of the IBL cycle take place depends on the topic, the context and the resources available. We encourage, when covering topics related to the environment, to go outdoors, to use natural materials and to use sensors to collect data in nature (read about this in Curriculum Module 4). While raising children's "awareness of environmental issues" is an important starting point, it is not sufficient on its own. Awareness must be complemented with the "acquisition of scientific knowledge, problem-solving skills, and other important habits and dispositions for lifelong learning" (Xunyi et al., 2021). Simply being aware of environmental challenges does not equip children with the necessary skills or knowledge to actively address these issues or contribute to sustainable development. Lifelong learning requires a broader set of competencies, including critical thinking and practical problem-solving abilities. Through Inquiry-Based Learning (IBL), young learners can move beyond simply recognizing environmental challenges to actively engaging in the processes of questioning, investigating, and understanding the natural world. This approach helps children build a deeper comprehension of ecological systems, enabling them to analyse problems, propose solutions, and reflect on the outcomes of their inquiries.

By integrating educational robotics within the IBL framework, children not only become more aware of environmental issues and eco-friendly practices but also gain the skills to interact with and respond to these challenges in meaningful ways. For example, they might learn how to programme a robot to sort recyclables or measure air quality, thus applying scientific principles in a practical context. This combination of awareness and skill-building ensures that children are not just passive observers but active problem-solvers who are prepared for lifelong learning and responsible environmental stewardship.

ROBOTICS

The joint use of the Inquiry-Based Learning approach and educational robotics in Early Childhood Education creates unique opportunities to help children understand complex environmental and eco-friendly concepts. IBL emphasizes a hands-on, exploratory approach where children engage in asking questions, conducting experiments, and reflecting on their findings. This approach becomes particularly effective when combined with robotics, providing a tangible way for young children to interact with abstract ideas. Educational robotics acts as a bridge between theoretical inquiry and practical application, making it easier for children to grasp challenging topics related to sustainability and the environment. For example, programming a robot to simulate the process of sorting recyclable materials or using sensors to monitor water levels in a classroom garden transforms abstract concepts into concrete learning experiences. These activities not only immerse children in scientific inquiry but also help them develop critical thinking, problem-solving skills, and an early understanding of algorithmic thinking. Additionally, integrating robotics into IBL allows children to see the direct impact of their actions and decisions, creating a sense of agency and responsibility. By working through real-world challenges in a guided but child-centred environment, they build the skills and confidence needed to explore new problems and seek innovative solutions. This approach supports the development of lifelong learning habits and ensures that environmental education is both meaningful and engaging for young children.

During preschool, educational robotics (ER) is one of the tools that can enrich the learning process by incorporating technological skills that can enhance digital literacy skills. ER has the potential to develop competencies in various fields not only in programming but also in mathematics, physics, art, languages and other areas. Practising preschool teachers have indicated that educational robots can serve as a flexible tool which is easily integrated into the various themes covered by the preschool curriculum. Almost all computational thinking components are experienced throughout the preschool day within the framework of play and in various everyday tasks and situations. However, to fully develop them and to combine them with initial knowledge of technology, it is necessary to look more widely into the field of possibilities offered by robotics. (Tumase, 2023) In preschool, an inquiry-based approach puts the focus on the children themselves, who then become active learners as they choose:

- which topics to explore,
- to research these topics,
- to decide what to produce,
- to create, or to solve,
- and then to reflect on what they have learned.

WHY TEACH CHILDREN ABOUT ROBOTICS?

Teaching young children coding can sound difficult, but there are many ways to get started. Coding skills will help to build a more creative, resilient, and confident generation of learners. Here are some reasons why we should consider teaching preschoolers about coding and robotics:

- They will learn how to break down a large problem into smaller pieces. They will start to use a **computer effectively as a tool**.
- They will start to **recognize and create** patterns and sequencing.
- They will learn that **symbols represent things** (symbols like letters of the alphabet represent sounds and meaning, symbols like arrows, text, and numbers represent position and movement, mathematical and language concepts).
- Coding helps to **take the fear out** of making mistakes or failing, it is about the process and finding solutions to problems.

Raising the next generation of innovators in a technology-driven economy, who can think and act in a sustainable way is extremely important. Educational robotics is a powerful tool to support this from an early age.

ENVIRONMENTAL EDUCATION

Environmental Education (EE) at the preschool level plays a crucial role in promoting children's understanding of the natural world and developing a sense of environmental responsibility. By engaging in hands-on activities and exploring nature, young children can develop a strong foundation for lifelong learning about the environment. Research has shown that Early Childhood EE can lead to increased environmental knowledge, positive attitudes towards nature, and pro-environmental behaviours (Chawla, 2009). For instance, studies have found that children who participate in nature-based preschool programmes are more likely to exhibit curiosity about the natural world and demonstrate a deeper understanding of ecological concepts (Louv, 2005). Chawla (2009) identifies three key factors that influence children's development of care for the natural world: motivation, efficacy, and knowledge of action skills and strategies. Socialisers, such as family members and teachers, play a crucial role in fostering children's motivation to care for the environment. Additionally, providing opportunities for children to experience nature firsthand and develop a sense of efficacy in environmental actions is essential. By incorporating these elements into Early Childhood Education, we can empower young learners to become agents of change for a sustainable future.

Inquiry-Based Learning Implementation

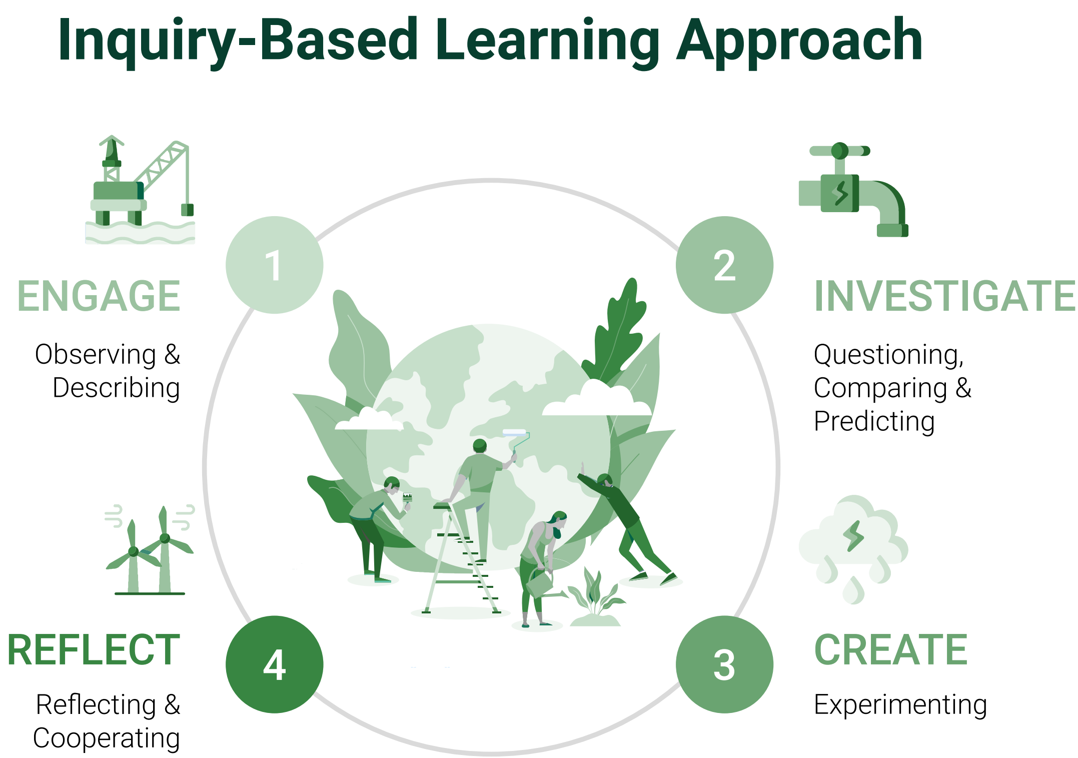
Can robotics and nature go hand in hand, or are they completely opposite fields where it is difficult to find a point of contact? A 2009 study (Greenfield et al., 2009) highlights eight skills that, when promoted at the preschool level, can help children understand and learn natural sciences. These skills are "observing, describing, comparing, questioning, predicting, experimenting, reflecting and collaborating" (Greenfield et al., 2009). Clearly these skills are very similar to those promoted in lessons with educational robotics. The skills in interaction and sequential facilitation within the lesson form the cycle of the IBL approach, and "(...) an effective programme must encompass all of these core skills and competencies to provide a science and engineering learning experience" (Xunyi et al., 2021). It can be stated that the IBL approach can serve as a meeting point between natural sciences and educational robotics.

Different references present the IBL approach skills in sub-divisions or in a combination of skills, but this does not change the content. Therefore, in the following section, we will introduce how they can be promoted step by step in ECE.

The IBL approach can be structured into 4 main stages - first observing, then questioning, predicting, and finally - evaluating (Hollingsworth & Vandermaas-Peeler, 2017). By linking all the described learner stages together, a cycle of 4 steps/stages of the lesson (see Figure 1.1) is formed (this could also be several consecutive lessons going through all these steps of the IBL).

Figure 1.1

Inquiry-Based learning approach



1. The first part of the lesson (or a series of lessons) - ENGAGE, which promotes learners' interest in the topic and/or the research question being investigated.

2. The second part of the lesson (or a series of lessons) - INVESTIGATE, encourages exploration of the topic - asking questions that need to be explored, researching information to answer questions and gain new knowledge, and comparing what is already known and what is being learned.

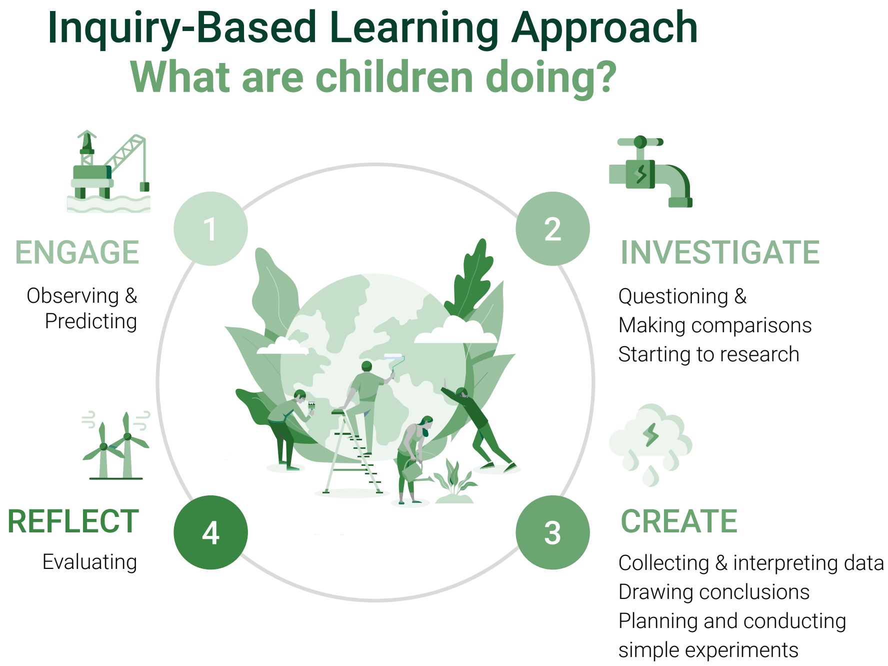
3. The third part of the lesson (or a series of lessons) - CREATE, focuses on the creation of new knowledge, skills and competences. This is the core of the lesson, where a predesigned activity (e.g. experiment) takes place.

4. The fourth part of the lesson (or a series of lessons) - REFLECT, is the final phase, which invites learners to summarise the experience, reflect on what has been done, and what has been learnt and propose further research questions on the topic.

Once the cycle is complete, we can ask questions about what *we have not yet explored and what we would still like to find out* - leading us to explore a different, but related topic or a different aspect of that same topic, so that the cycle starts again on a new topic.

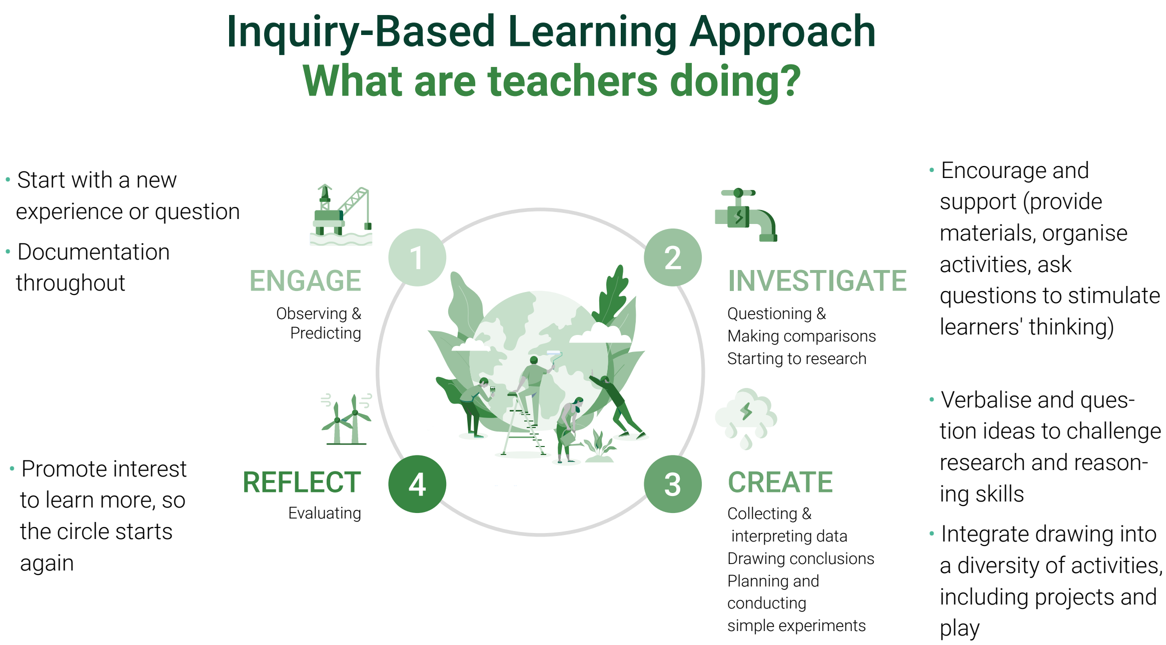
Inquiry-Based Learning is founded on the principle that children take the lead in guiding the process through each step (see Figure 1.2).

Figure 1.2
IBL – What are children doing?



Although the IBL approach requires a learner-driven, self-directed learning process, the teacher's supportive role is crucial (see Figure 1.3).

Figure 1.3
IBL – What are teachers doing?



- First of all, the teacher needs to plan the process - both the introductory part, where the children will be guided into the topic, and the planning of the activities that will achieve the pre-defined outcome - will it be an experiment, will it be a learner-made presentation, will it be project work, or will it be an activity with the educational robot?
- Secondly, the teacher should offer as wide a range of reference sources as possible to enable children to explore the topic and find answers to the questions (children's encyclopaedias, images, video/audio material, reliable internet resources, etc.).
- Thirdly, it is very important to challenge children's ability to explain their ideas or to stimulate a deeper understanding of the topic by asking different types of questions during the process.
- Fourthly, throughout the cycle, the teacher should document the children's achievements to be able to evaluate the process, adjust their work and give feedback to the children and parents.

To further enhance the IBL approach and its connection to environmental education and robotics, we can incorporate environmental data collection, treatment, and interpretation. This integration can provide a rich learning experience for children, allowing them to actively engage with the natural world and develop critical thinking skills. However, teachers and educators especially in preschool can support this by asking questions, assisting with information searches, and providing guidance to help children acquire these skills. Using this approach, we can emphasise environmental awareness and sustainability, promoting children's understanding and appreciation of nature while simultaneously developing their analytical and critical thinking abilities.

A table outlining each IBL step, along with potential activities in the fields of educational robotics and nature, can be found in Module 6.

Adapting Inquiry-Based Learning to the Needs of Early Childhood Education

Most countries have a preschool curriculum, with guidelines, outcomes and learning objectives. The learning outcomes are mainly divided into different learning areas. The focus of this GREENCODE resource is on environmental awareness, integrating the skills of the technology learning area. However, the concept of the IBL approach can be adapted to the different topics and learning outcomes, depending on each country's preschool regulatory documents.

The materials developed within the GREENCODE project are designed specifically for children between 3 and 7 years. It should be noted that 5–7-year-olds can perform more complex tasks, following cognitive and developmental stages where children begin to demonstrate greater ability to think logically, solve problems and engage more deeply in Inquiry-Based Learning approaches. At this age, children can better formulate questions, conduct simple investigations, and reflect on their learning experiences, making them ideal candidates for more structured IBL steps. Younger preschoolers (3 to 4 years old) can benefit from IBL by participating in simplified inquiry activities that match their developmental needs and interests. The IBL approach can be tailored to accommodate their shorter attention spans and different learning styles, ensuring that even younger children can explore and experiment within a supportive and playful learning environment.

There can be challenges to adjusting the content and IBL approach to the child's developmental and intellectual abilities. Nevertheless, the stages of children's development are similar in all countries, and it should be emphasised that this one year at preschool is of great importance. The table below focuses on the characteristics of cognitive development in children aged 5 to 7, illustrating the differences between these age groups. It is structured this way to highlight the developmental changes that occur during this period, which directly impact how the IBL cycle is adapted and implemented (see Table 1.1).

Table 1.1
Characteristics of cognitive development of learners at the preschool education level

5 years old	6 - 7 years old
· significantly improved eye-focusing abilities, · control over small and large motor skills, · language skills improve, vocabulary expands rapidly, · improving concentration and memory, · ability to see and understand symbols, use imagination, · can imitate an action, can imagine a situation, can fantasise, · focuses on one aspect at a time, · empathises from their own perspective, · attributes personality to inanimate objects, · difficulty in separating fantasy from reality.	· logical thinking begins to develop, · an understanding of mathematical concepts develops, · the beginning of seeing causal relationships, · the ability to understand their peers, to put oneself "in their shoes".

Note. Adapted from "Kids and the internet: A developmental summary", by M. Baumgarten, 2003, *Computers in Entertainment (CIE)*, 1(1).

Table 1.1. underscores developmental differences between 5-year-olds and 6/7-year-olds such as improved motor and language skills, enhanced concentration, and the shift from egocentrism to a greater

understanding of others' perspectives. **It's important to note that these are general developmental milestones and individual children may progress at different rates.** Many factors can influence a child's development, including genetics, environment, and experiences. **This table provides a framework for understanding typical development, but it's not a strict guideline.** The IBL approach can be adapted to suit each child's unique needs and abilities, as they progress through these developmental stages.

KEY BENEFITS

Inquiry-Based Learning (IBL) offers numerous benefits for preschool children, particularly those aged 5 to 7, whose cognitive abilities align well with the approach. The table outlining the cognitive development characteristics of 5- to 7-year-olds is directly relevant to understanding how IBL supports these benefits:

Encourages natural curiosity. At age 5, children show an increasing ability to focus their attention and engage in activities for longer periods. This makes them more capable of participating in inquiry-based activities, such as observing nature or experimenting with simple materials. The IBL approach uses this developmental stage to guide children in asking questions, exploring their surroundings, and seeking answers through hands-on activities.

Develops critical thinking skills. As children progress towards age 6 and 7, they begin to develop logical thinking skills and understand causal relationships. IBL capitalizes on this by encouraging children to analyse and interpret information. Activities that involve predicting outcomes, testing hypotheses, and comparing results help children build a foundational understanding of cause and effect, which is crucial for scientific thinking.

Enhances communication skills. As language skills and vocabulary expand at age 5, IBL steps that involve group discussions, describing observations, and sharing findings support the further development of communication skills. By age 6 and 7, children's growing ability to consider others' perspectives helps them in engaging more effectively in collaborative inquiry projects, where they learn to articulate their ideas and listen to others.

Promotes independent learning. IBL empowers children to take the lead in their learning process. At ages 6 and 7, children become more capable of planning simple investigations and reflecting on their learning experiences. This ability to organize their thoughts and actions supports their development of independence, as they learn to make decisions and solve problems with minimal adult intervention.

Builds a foundation for lifelong learning. The transition from egocentric thinking in 5-year-olds to a greater understanding of others' perspectives in 6- and 7-year-olds allows children to engage more deeply in reflective practices. IBL uses this progression to encourage children to think about their learning process, understand the relevance of their discoveries, and cultivate a mindset that values continuous exploration and learning.

By tailoring activities to these age-specific abilities, IBL ensures that young children are engaged in meaningful, age-appropriate explorations that help them develop crucial skills for their future education.

OTHER RECOMMENDATIONS FOR THE IMPLEMENTATION OF THE IBL APPROACH

Interdisciplinary approaches support children's awareness of these issues outside the preschool and raise the awareness of caring for the environment. Carbon footprints, for example, walking to the preschool rather than driving, children taking part in litter collection and cleaning up beaches within their local communities.

Useful to **bring in outside professionals or experts** such as local council representatives, and voluntary organisations, bringing in experts in recycling, for example, to talk to the children and going on visits within the community.

Sharing this with parents, families and care givers is important through workshops and newsletters.

By engaging children in **hands-on activities,** such as building and programming robots to collect environmental data or design sustainable solutions, we can cultivate a deep understanding of environmental issues and inspire a lifelong passion for learning and innovation.

By **combining** IBL, environmental education, and robotics, we can create engaging and meaningful learning experiences for young children.

MODULE 2

Supporting the Implementation of IBL in ECE

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Children Learn through Exploration

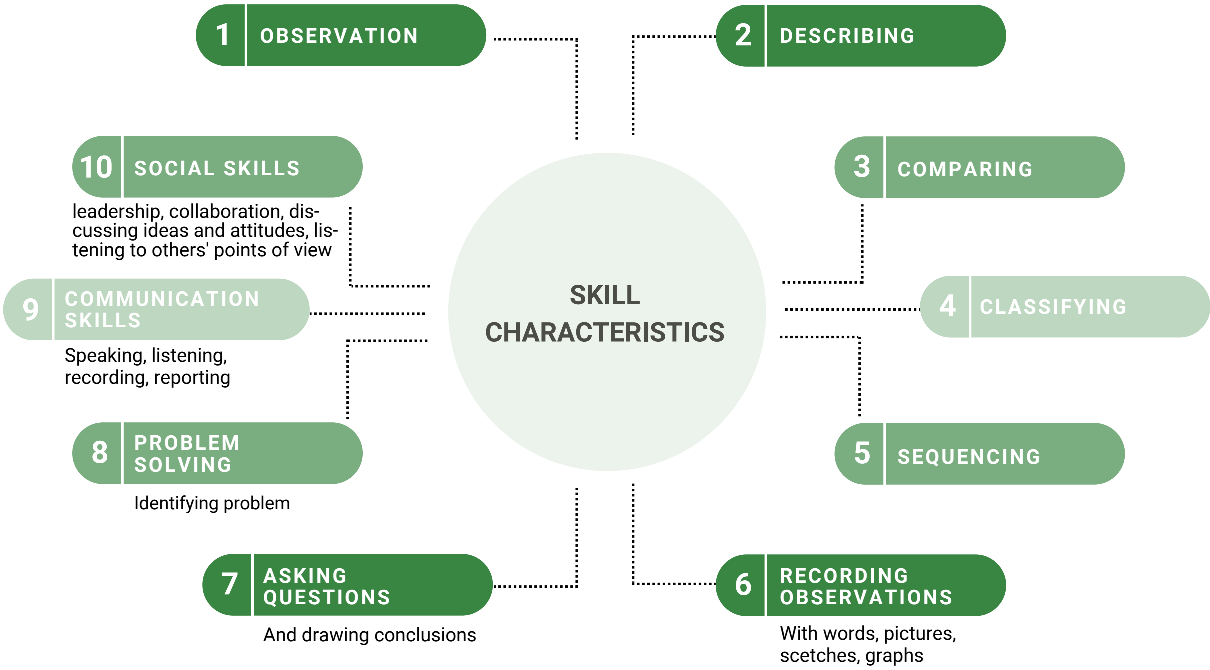
Play, exploring and learning are the main activities of a re-school child through which they come to know and understand the world around them. Continuous observation of individual children has shown that the child constantly builds, expands, reorganises and reconstructs their knowledge and does not passively absorb it from their environment.

Thornton and Brunton (2014) highlight the following scientific skills (see Figure 2.1), which children can develop in the context of cognitive exploratory activities: observation (using all senses), describing, comparing, classifying, sequencing, recording observations through words, pictures, sketches and graphs; asking questions and drawing conclusions; problem-solving and problem identification; communication skills (speaking, listening, recording, reporting); social skills (leadership, collaboration, discussing ideas and attitudes, listening to others' points of view).

In addition, it is well known and confirmed by scientific research that young children learn by exploring the world around them, they learn by doing, observing and participating. Teaching is in the form of "explaining" or "traditional teaching" or "instruction centred teaching".

In research activities, which have the greatest educational potential, children learn teamwork, learn to live in a democracy, all from an early age. Children do not need to be particularly interested in research, because research is an integral part of their lives. Therefore, it is important to provide the right conditions in the organisation, and this primarily means a qualified, sensitive teacher who accepts and supports such work (Vujičić et al., 2016).

Figure 2.1
Skill Characteristics



To understand how a child understands, we need to be able to observe and listen to them as they apply what they know. Documentation is of great help as a fundamental tool for understanding a child's knowledge formation in the early and preschool years (Giudici et al., 2001).

The child needs to become aware of what he is doing to be able to re-apply his competence in another context (returning to the cognitive processes used during the acquisition of knowledge). This is a complex act of thinking, as it simultaneously depends on knowledge and skills from a particular area, the context of use and the cognitive processes applied to materialise the whole. This means, as Halpenny (2021) states, having knowledge of knowledge, i.e. meta-knowledge that should enable children to expand their field of awareness and their ability to reuse what they know in a different context. The adult, the teacher, is expected to listen carefully to what the child says before asking the next question, to consider what kind of questions to ask the child, or how to formulate the questions in a way that opens a perspective for the child to respond or encourages the child to think, rather than just providing an answer for the sake of answering.

For example: "What do you think?" – an open question that invites the child to express his/her thoughts and ideas. Furthermore, good questions invite or deepen further exploration: "I am interested or I'd like to know what will happen?" or "How can we investigate it?", "What will happen if ...?", "What can you try instead?", "What does this remind you of?", "What can you do next time?", "How will you do it?", "Is there anything else you could use or not?", "Why did you decide to try that?", "Why do you think it will work?", "Where can you get more information?", "How do you know?", "What is your evidence?".

However, it is not only important to ask children questions, but also to encourage them to ask questions, to give them the opportunity and the chance to ask questions that will make the teacher think. Instead of offering answers and quick solutions, the teacher's role is to encourage children to think, to form hypotheses, and to seek ways to solve a particular problem.

In other words, asking questions has great educational potential, and it does matter how and in what situations questions are posed to children. There are two key moments that are definitely undesirable (Kyriacou, 2001): First, if the educator directly asks questions, children may perceive it as a knowledge test; and second, the questions cannot be planned in advance because the educational process is dynamic and unpredictable and rigid structures (such as pre-planned questions) can hinder the teacher's ability to recognize anything unexpected in a conversation with children. An equally important aspect of asking questions is the need to provide positive reinforcement to the child, meaning that his/her opinions should be listened to and valued, even if what the child is saying is not always what the adults—i.e., the teacher—expect (Kyriacou, 2001). The questions asked to the children should be measured in both quantity and quality.

Learning and Teaching Strategies to Support the IBL Approach

Planning IBL activities includes the following steps: generating the motivation for the topic, making predictions and hypotheses, investigating and researching the topic and questions, developing learner-centred conclusions, sharing and discussing ideas, and reflecting.

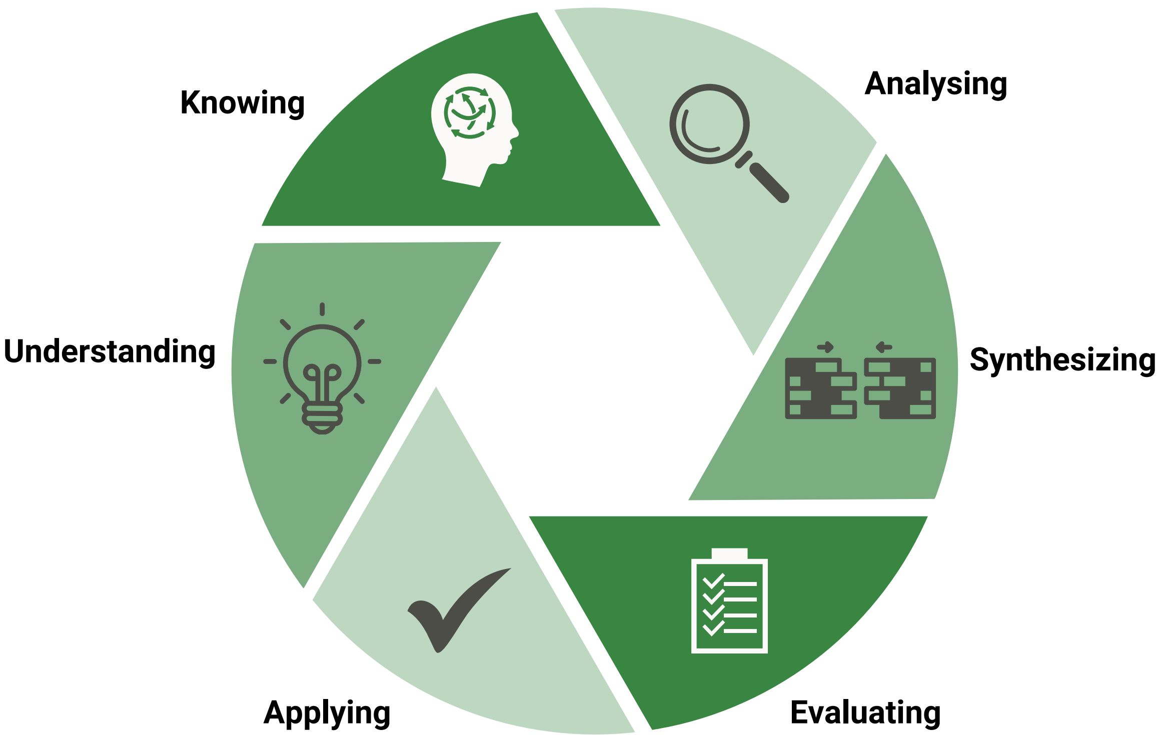
Motivation usually starts with an impulse or challenge, the so-called "spark", given by the teacher at the beginning of the activity. The children participate in the activity by responding to the spark.

One of the successful strategies involves finding out what children already know, acquiring new knowledge, and consolidating that knowledge through practical application. Children learn better when they connect existing knowledge with new knowledge. By giving them the opportunity during activities to demonstrate what they know about a particular topic, we encourage their curiosity and anticipation of what will happen next. Learning and teaching strategies should move away from simple memorization of facts. For children to be able to solve certain problems, they need to be encouraged to use all learning processes (judging, reasoning, creating, inventing, etc.). Children learn better when they initiate their own learning and can develop critical thinking and problem-solving skills through exploration.

Collaborative learning and democratic strategies involve creating a sense of value in children, encouraging decision-making, respecting their beliefs and values, and promoting cooperation rather than competition. Democratic strategies promote equal participation of all children in the group. Through this, children learn to rely on others, as well as help others to achieve a common goal. By working in groups, pairs, or teams, gathered around a shared research task (such as a project as a form of integrated learning), children learn to appreciate the multiple intelligences of others and different learning styles (Murray, 2017).

Promoting the development of key thinking skills in children is closely linked to asking simple questions. By asking simple questions, we stimulate children's thinking in an appropriate way and make learning enjoyable. For this reason, the material titled Council for Exceptional Children is highly useful, as it outlines six key thinking skills in children: knowledge, understanding, application, analysis, synthesis, and evaluation (see Fig 2.2).

Figure 2.2
Six key thinking skills for children



Knowledge represents a thinking skill and encompasses the ability to remember and recall (when necessary) acquired information to form responses, that is, solutions to emerging problems, as well as to provide factual answers. Knowledge can be defined as the ability to recognise and understand facts, information, descriptions, and skills acquired through experience and education, through observation, independent discovery, and learning. Knowledge can be viewed as both theoretical and practical understanding of a particular topic. It can be implicit, involving the possession of practical skills, or explicit, involving the theoretical understanding of a certain subject.

To stimulate the acquisition and creation of knowledge, it is necessary to ask questions that begin with phrases such as: Where?, When?, How much?, Describe!, Identify!, etc., which encourage the formation of fact-based answers and the ability to memorise information in preschool children.

Understanding is a thinking skill that encompasses the ability to comprehend acquired or gained knowledge and information. To stimulate the skill of understanding in children and support their continuous development, it is necessary to ask simple yet appropriate questions. Such questions begin with phrases like: Describe!, Explain!, Evaluate!, Recognize!, etc., which encourage children to interpret the knowledge and information they have acquired.

Application as one of the key thinking skills of children involves the ability to apply acquired knowledge and information in concrete, new and unfamiliar practical situations. To encourage the skill of applying acquired knowledge and information in new and unfamiliar situations, simple questions can be asked, beginning with the phrases such as: Show!, Solve!, Investigate!, Experiment!, Apply!, etc., which encourage children to apply the acquired knowledge and skills in the situations they encounter, where these can be repetitive, i.e. new and familiar situations and unfamiliar situations.

Analysis is the ability to break down information into parts and examine acquired information and knowledge, as well as the effort put into understanding the organisational structure of the information. The term analysis can be defined as the process of breaking down a complex topic into simpler parts to gain a more detailed and in-depth understanding of the topic. Through analysis, knowledge is gained about the connections between individual parts of a certain topic, as well as knowledge about cause-and-effect relationships. The analysis of a specific topic or situation can be carried out in several ways, including the analysis of elements, analysis of relationships and analysis of organisational principles. To encourage and stimulate the development of thinking skills in early and preschool aged children, it is necessary to ask simple and appropriate questions, which may begin with phrases such as: What is the difference between this and that?, Analyse!, Explain!, Compare!, Classify!, etc. These questions aim to encourage children to break down acquired complex knowledge and information into simpler parts, allowing for the acquisition of detailed and in-depth knowledge of the topic.

Synthesis is the skill of applying previously acquired knowledge, skills, and information to form new patterns of behaviour. Synthesis is the process of connecting information in different and new ways to enable the formation of new behaviour patterns and alternative solutions to known problems. Through synthesis, it is possible to create unique communication, design plans, and derive abstract relationships.

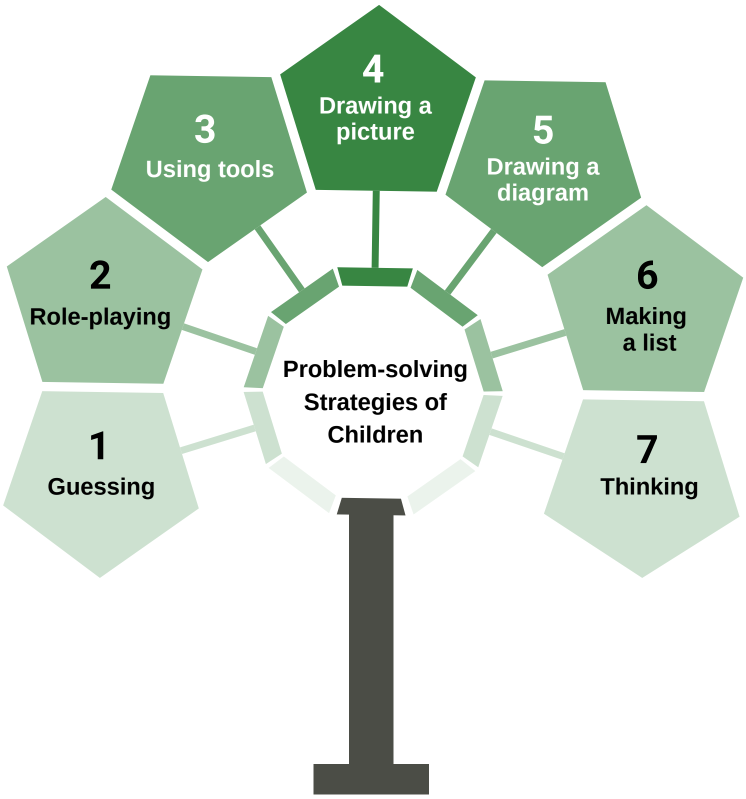
To enable the development of synthesis skills in early and preschool aged children, it is necessary to ask questions that begin with phrases such as: Combine!, Replace!, Reorganise!, Form!, Invent!, What if (...)?, etc. These questions encourage children to create new combinations of acquired skills, knowledge, and information to form new patterns of behaviour.

Evaluation involves making decisions based on a specific set of criteria and requirements, with no clear boundary between correct and incorrect answers. Evaluation is a thinking skill focused on making judgments and decisions about acquired knowledge and information, as well as the validity of certain ideas based on established or predefined criteria. To encourage and stimulate the process of evaluation in early and preschool aged children, it is necessary to ask simple and appropriate questions that begin with phrases such as: Evaluate!, Decide!, Choose!, Explain!, Compare!, Summarise!, etc. These questions encourage children to understand and think about criteria, as well as apply them in specific situations, with the aim of evaluating and making judgments about them.

Problem-Solving Strategies

Problem-solving is a tool, a process and a skill. It is the process of finding a solution to a problem to achieve the set goals. There are different problem-solving strategies (see Figure 2.3). The most common problem-solving strategies used with children include: guessing, role-playing, using tools, drawing a picture, drawing a diagram, making a list and thinking.

Figure 2.3
Problem-solving strategies



Note. Adapted from the New Zealand Ministry of Education.

Guessing is a common problem-solving strategy with children and involves two strategies. These strategies are "*guess and check*" and "*guess and improve*".

Guess and check is the simplest problem-solving strategy for children and consists of guessing a possible answer to the current problem. After guessing, the children check whether the guessed answer fulfils the conditions required to solve the problem. As this is a very simple problem-solving method, it is possible to encounter difficulties when trying to direct children towards other strategies. Furthermore, this strategy becomes less effective as the complexity of the problem increases, so other strategies must be sought. In the case of a complex problem, the *guess and check* strategy can be a first step in exploring the problem, allowing children to discover a more efficient strategy that leads to the discovery of a solution.

Guess and improve is a more sophisticated version of the guess and check strategy. The basic idea behind this strategy is to use an incorrect attempt to generate an improved next attempt. In the case of simpler problems, it is easy to improve upon an incorrect attempt. However, when dealing with more complex problems that involve multiple variables, it is sometimes unclear how to improve the initial incorrect attempt.

Role-playing is a problem-solving strategy that children often use by taking on the roles of specific subjects involved in the problem. This strategy has both advantages and disadvantages. It is an effective strategy when there is a need to demonstrate the problem within a group, but it may have drawbacks if too many children are using it simultaneously. It is most often a highly effective strategy when children have difficulty with the initial understanding of the problem.

The use of tools is a strategy related to the role-playing strategy. Any object (item or toy) that the children use to solve a problem is called a tool. One of the difficulties in using tools is monitoring the correspondence between the use of the tools and the solution to the problem. Children are encouraged to monitor and coordinate the tools during the process of solving the problem and to monitor the process of their own work. Children usually need to be encouraged to use tools when solving problems, as they often prefer to choose other strategies that give them a better idea of the problem, such as drawing. To encourage children to use this strategy when solving problems, it is necessary for teachers to use the tools themselves when carrying out certain activities and when finding solutions to specific problems, so that children can form an understanding of the strategy.

Drawing a picture is a problem-solving strategy for children that doesn't need to be carefully planned; the drawing should only include the necessary details required to solve the problem. When using the drawing strategy, some children should be encouraged to use the simplest scheme possible, but all children should be encouraged to use this problem-solving strategy, as it helps them form a visual representation of the problem, and as t it can be developed into a very sophisticated problem-solving strategy.

Drawing a diagram is a strategy related to *Drawing a picture* strategy. This strategy involves drawing anything other than a picture to solve a problem. Drawing a diagram helps in gaining an understanding of the problem. Namely, the diagram represents the problem itself, making it visible, which facilitates defining the next step in finding its solution. An example of the most common diagram used by children when forming a visual representation of a problem is a branching diagram.

Making a list is an organised problem-solving strategy. It includes two strategies: *making a list* and *making a table*. This strategy represents a process of systematic problem-solving, and its use involves smaller calculations which enables children to develop solutions logically and systematically. When organised lists are used to solve a problem, they imply the creation of a natural order that is appropriate for the specific problem, i.e. for its solution.

Thinking is a sophisticated problem-solving strategy. Regardless of the cognitive development stage children are at, thinking as a problem-solving strategy is used in combination with other strategies. The most combined strategies include (according to the New Zealand Ministry of Education): systematisation, tracking progress, finding patterns, using symmetry, and applying acquired skills.

Systematisation is a strategy that involves creating tables or organised lists to track progress in developing a solution. It requires the application of logic and ensuring that all possible scenarios are considered. This strategy involves shaping and tracking the idea that has the best chance of forming an effective solution, rather than pursuing multiple ideas that may lead to a solution.

Monitoring progress is an effective strategy when a larger group of children is solving a problem. If this strategy is neglected, problems can arise in keeping track of what has already been done. By monitoring progress, repetition of completed tasks is eliminated. Children need to know what they have done and what they are currently working on to avoid getting stuck in problem-solving. This strategy becomes even more important when dealing with complex problems.

Finding patterns involves finding connections between the elements of a problem and determining how things work. It facilitates finding a solution to the problem by showing how a group of objects functions. By finding a pattern, control is gained over shaping the solution to a specific problem.

Using symmetry allows children to reduce the complexity of the problem. Identifying symmetries reduces the number of possible solutions, making the problem easier to analyse.

Applying acquired skills is a common problem-solving strategy. It involves identifying familiar skills that can be applied to develop effective solutions to problems and then applying them. This is closely related to the initial step of problem-solving, especially when dealing with problems such as those a child has encountered in the past.

Table 2.1, developed by the authors in the project covers all steps of the Inquiry-Based Learning approach and provides recommendations for various strategies and activities for its implementation.

Table 2.1
Strategies and activities supporting IBL steps

Steps of IBL	Strategies supporting IBL steps	Activities supporting IBL steps
ENGAGE	The use of acquired skills Guess and check Guess and improve	Teachers can tell a story or show a video clip about nature or robotics to stimulate the children's interest in the topic. Through the conversation, teachers can assess children's knowledge of the topic, that is, how they carry out certain tasks and activities. The children can also get involved by sharing their own experiences on this topic.
INVESTIGATE	Role-playing The use of tools Drawing a picture Drawing a diagram	The children can describe finds using drawings or simple descriptions with the help of lists or drawings. They can demonstrate their observations using descriptive and critical thinking skills by asking questions, collecting data, comparing and making predictions. The teacher can provide some data and then let the children find it themselves or during a game. The teacher can encourage the children with questions such as: "So we could...?"; "What do you think would happen if...?"; "What do you think it could be?"; "Can you think of any ways to...?"; "What else can we try?"; "Have you seen/heard/felt...?" etc.
CREATE	Making a list Using symmetry Finding patterns Systematisation	The children can analyse the collected data, plan further research or experiments and interpret the results. The teacher guides their analysis by asking: "How do you want to do it?", "Is there anything else you could use?", "Why did you decide to try it?", "Why do you think it will work?", "Where can you get more information?", "How do you know...?"
REFLECT	Monitoring progress Role-playing Drawing a picture Drawing a diagram	The children can interpret what they have learned or how they have solved the problem. They can draw a picture of what they have learned, make up a story or make up and perform a play. For reflection, the teacher can stimulate discussion with questions such as: "What did you notice about...?", "What do you conclude from this?", "If you had to do it again, what would you change?", "What would happen then?"

Education of Preservice Teachers for the Implementation of the IBL Approach in ECE

Children start using technology at a very early age. Therefore, it is important to teach them the basics of technology and introduce basic concepts such as the components of coding and robotics. Taggart et al. (2005) point out that while organising the teaching and learning process, preschool teachers should include games that encourage children to solve problems and ask questions, and include challenges that will stimulate children's creative, reflective and analytical thinking skills. Preservice teachers should know how to incorporate technology into eco-friendly teaching strategies. How to encourage children to make up stories and share their ideas could be one of the tasks to evaluate potential preservice teachers in the field of IBL. Based on storytelling and environmentally friendly situations, they should engage children in inquiry-based conversations. For example, finding a solution to a problem involving a robot in a playground full of litter which it must clean up by sorting the litter into the different bins provided.

Interdisciplinary approaches can be planned through nature trips, simple drama activities, coding activities with an environmental approach, purposeful use of natural materials, and different project activities like planting, gardening, reusing things, etc.

The fundamental components of teaching and learning are related to assessment and evaluation. Assessment is the process of collecting and documenting information about each child's learning, while evaluation can be defined as a process of analysing, reflecting, summarising, and making decisions based on information. The basic aims of assessment and evaluation are to inform the learning process and to use the information gained to improve existing learning. These processes aim to examine what children know and how they perform certain tasks and activities. They are based on observation of children's thinking rather than specific task solutions and outcomes. The best way to assess and evaluate children's learning and thinking is through documentation. Documentation of the educational process plays a key role in emphasising the complexity and dynamics of educational practice, which goes beyond the *question-answer* and *problem-solving* model, but it requires continuous searching and exploration in shaping the curriculum of the group (kindergarten) that will truly align with the nature of the children (Vujičić, 2020). For these reasons, the focus of documentation shifts from documenting activities to documenting the meaning that these activities have for children and teachers, and from documenting individual characteristics of children to documenting situations in observing, analysing and understanding children's learning (Formosinho & Petters, 2019). Pedagogical documentation understood in this way enables evaluation in action: collecting and taking time to preserve what we value and give importance to (Vujičić & Miketek, 2014). Through documentation, - the term visible listening (Vecchi, 2010) and visible learning (Giudici et al., 2001) is used in the Reggio Approach, - dominant discourses and preconceptions can be uncovered, identified and imagined, which then form the basis of our own practice and from which we build not only an image of the child, but also an image of ourselves as teachers.

In documenting educational practice, which requires careful observation of children and reflection by teachers, teachers can recognise children as capable learners who continuously shape their own knowledge and theories. In this process, the goal of the teacher is not to determine what children need to know, but rather to identify what they already know. If teachers view children as capable and active subjects who are constantly exploring their environment and the way the world works, then new and potential ways of establishing interactions and building quality relationships with children emerge, leading to new ways of thinking and conducting educational practice. By observing children in a different way, teachers are led to reconsider their own role. Instead of taking on the role of knowledge transmitters, teachers become participants in the process of knowledge creation, by observing the communication between children, as their important task is to create learning situations that allow children to engage in discussions and understand the perspectives of others.

By reflecting on their own work and documenting their thinking, children can be encouraged to relive their experiences and further develop their own ideas in detail. By documenting children's play and conversations, children realise how much teachers value their work. This can encourage them to continue putting effort into their own projects and work. Moreover, the documented materials encourage the development of a positive and respectful culture within the preschool group and the entire early childhood and preschool education organisation.

MODULE 3

The Importance of Outdoor and Indoor Activities for Environmental Education in ECE

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Nature-based experiences in Early Childhood Education are crucial for all areas of the curriculum - as well as children's development. When thinking of Environmental Education, the importance of the outdoor space and experience becomes even more salient. In this chapter, a review of the main benefits is followed by some suggestions of activities to be carried out outdoors.

Benefits of Outdoor Experiences for Children

Outdoor experiences for children in Early Childhood Education usually refer to activities and learning opportunities that take place in natural outdoor environments. These can include playgrounds, parks, forests, beaches, or even the school's own backyard. The playground is a crucial component of outdoor experiences for children. It provides a safe and accessible space for children to play, explore, and learn.

Some examples of outdoor activities in Early Childhood Education are represented in Figure 3.1.

By providing opportunities for outdoor play and exploration, teachers can support children's holistic development and foster a lifelong love of learning and the natural world. Playing outside is an important experience for children. Here are some of the main arguments for incorporating outdoor play into Early Childhood Education.

Figure 3.1
Examples of outdoor activities in Early Childhood Education

PHYSICAL DEVELOPMENT

- Gross motor skills: Outdoor play provides ample opportunities for children to develop and refine their gross motor skills, such as running, jumping, climbing, and balancing.
- Fine motor skills: Activities like digging, pouring, and manipulating natural materials can help children develop their fine motor skills, which are essential for tasks like writing and drawing.
- Healthy growth: Regular physical activity promotes healthy growth and development, reduces the risk of obesity, and strengthens bones and muscles.

COGNITIVE DEVELOPMENT

- Problem-solving: Outdoor play often involves problem-solving, such as figuring out how to climb a tree or navigate a playground obstacle course.
- Creativity: Exploring the natural world can spark creativity and imagination. Children can invent games, stories, and art projects based on their outdoor experiences.
- Sensory exploration: Outdoor environments offer a variety of sensory experiences, allowing children to explore textures, sounds, smells, and tastes.

SOCIAL AND EMOTIONAL DEVELOPMENT

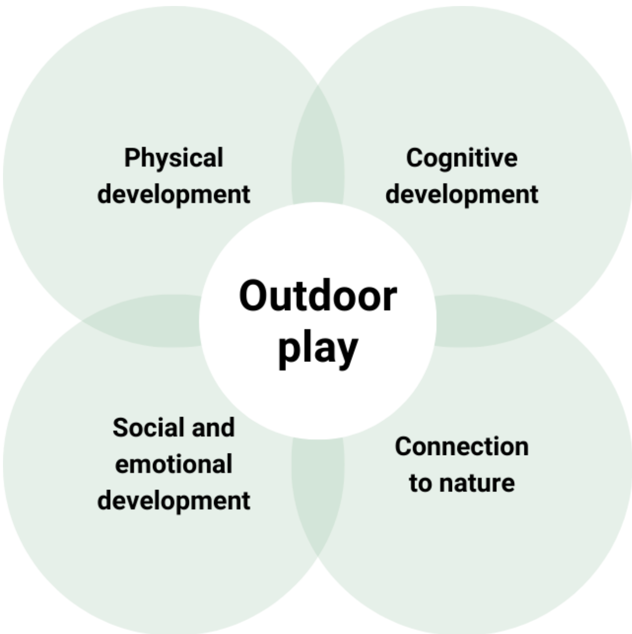
- Social interaction: Outdoor play provides opportunities for children to interact with peers, develop social skills, and learn to cooperate and share.
- Emotional regulation: Spending time in nature can help children regulate their emotions and reduce stress.
- Confidence and self-esteem: Mastering new skills and challenges outdoors can boost children's confidence and self-esteem.

CONNECTION TO NATURE

- Environmental awareness: Outdoor play helps children develop a connection to nature and an appreciation for the environment.
- Sustainability: Early exposure to nature can foster a sense of responsibility for the planet and a desire to protect it.

In conclusion and as shown in Figure 3.2, incorporating outdoor spaces into Early Childhood Education is crucial for promoting children's holistic development. By providing opportunities for physical activity, cognitive stimulation, social interaction, and emotional well-being, outdoor play can have a lasting positive impact on young children's lives.

Figure 3.2
Areas of development related to outdoor play



ACCESS TO NATURE AND NATURAL SPACES

An extensive body of research demonstrates that, particularly, access to nature positively impacts various aspects of children's lives. Access to nature can promote children's physical health and reduce sedentary time, mental health and wellbeing, as well as overall health, for example, by reducing myopia levels and boosting immunity, cognitive performance and social competences as well as creativity and imagination, and curiosity, scientific method, and connections between concepts.

In addition to all the benefits listed, one of the greatest benefits to highlight is the connection with nature and the concern for its conservation. Pedagogical childhood experiences with nature have long been regarded as a powerful solution to environmental problems. Direct experiences with nature in early childhood contribute to care for nature across their lifespans (Chawla, 2020; Elliott & Hughes, 2023). Children with more nature connection show more nature friendly behaviours such as putting out food for birds and joining nature clubs. They also show eco-friendlier attitudes and behaviours such as saving energy and recycling and demonstrate eco-friendlier actions such as participating in environmental volunteering and discussing the significance of protecting the environment with others (Chawla, 2020; Ernst et al., 2021). Among adults, a stronger connection to nature and environmental knowledge is linked to having more access to and interaction with nature during childhood (Chawla, 2020). However, the explicit connection between nature experiences and global sustainability in Early Childhood Education is a relatively recent development (Elliott & Hughes, 2023).

Research shows that attitudes and values toward the natural environment are shaped during childhood. Preschool children enjoy being in nature, have a desire to engage in nature-based activities, and show great empathy and interest in nature. But an environmentally active adult mentor is essential to inspire and guide children's engagement with nature (Chawla, 2020; D'Amore & Chawla, 2020). These professionals should engage children in positive experiences with nature, because connecting children with nature primarily involves positive experiences (Chawla, 2020). Sobel (1996) argues that it is important for children "to have the opportunity to bond with the natural world, to learn to love it, before being asked to heal its wounds" (p. 10).

Inspiring Examples from Practice

GARDENING

Some children and their teacher, from a Reggio-inspired preschool in the United States, were observed in several garden activities, for example, preparing the garden beds, planting, and harvesting. Through the gardening activities, preschoolers engaged in science rich dialogues, operating complex and abstract scientific competences such as observing, predicting, evaluating, and comparing. Conversation about numerical concepts, spatial understanding, and assessing and contrasting sizes also occurred frequently during the gardening tasks. Furthermore, examinations of social exchanges and conversations concerning gardening expertise and ecological awareness suggested that engaging in garden work with the right teacher's orientation and care provided a genuine setting for appreciating, understanding, and caring about the natural world (Vandermaas-Peeler & McClain, 2015).

COTTON

Kim et al. (2019) described the effects of a cotton project in a garden-based curriculum in South Korea, for 4- to 6-year-old children. They explained that planting cotton and observing its growth fostered a scientific mindset of curiosity and inquiry among the children. Through the cotton project, the children experienced the plant life cycle, which enhanced their sense of wonder, encouraged perseverance through trial and error, and taught them to keep an open mind to various possibilities. This direct and tangible interaction with the natural environment also heightened their awareness of nature's importance and the value of living in harmony with it, leading to more nature-friendly attitudes. The children became deeply engaged as they watched the seeds grow and change, and they cared for the plants. They understood nature's significance and recognised their role in its conservation. The teachers played a crucial role in this project by designing it to promote active, hands-on learning suited to the children's level, helping them connect with nature, internalise their learning, and build knowledge collaboratively.

EXCURSIONS

Elliot et al. (2014) observed children during excursions to an old-growth forest and a beach, documenting their fascination with the sensory details of plants, animals, and other natural elements. She noted their empathy for living things and their deep involvement in overcoming physical and emotional challenges, either through individual effort or teamwork, such as climbing over a fallen log. Elliot's observations also highlighted the social environment created by teachers, who established a "community of safety" through various safety measures, encouraged collaborative thinking and helpfulness, and fostered the children's close observation and empathy for living things.

NATURE PRESCHOOL

Kharod et al. (2018) described how a four-year-old girl transitioned from biophobia (the fear of nature and other living things) to biophilia (affinity for nature and other living things) while attending a nature preschool. This transformation was significantly influenced by her social interactions with peers and adults. The girl had numerous opportunities to observe how her peers and the adults expressed their affinity for and interest in the natural world. The curiosity of other children about small creatures like spiders and caterpillars, and their enjoyment of puddles, particularly stimulated her own interest in nature. Supportive teachers and the freedom to explore similar behaviours at her own pace were also crucial factors. The adults, with their expertise in early childhood and environmental education, fostered a connection to nature through a deliberate yet non-directive approach. Finally, the girl exhibited curiosity, wonder, a desire for direct contact with natural elements, and an appreciation and care for other living beings.

TRANSFORMATION OF THE OUTDOOR SPACE

In an Early Childhood Education setting in Portugal, a project was initiated to explore the outdoor environment with a group of young children. Despite having a spacious and well-equipped outdoor area with various natural elements and play structures, the children initially did not regularly use the outdoor space. The project's goal was to shift educational practices from frequent indoor activities to regular outdoor engagement. Throughout the project, various aspects of outdoor play emerged, including contact with natural elements, the importance of risk, and socialisation opportunities. Activities involving soil and water play provided integrated learning opportunities in mathematics, science, and language. As children filled and emptied containers, they explored concepts of weight, volume, and time, and acquired new vocabulary through discussion. Risky play also led to significant discoveries and learning. For instance, when wild mushrooms appeared in the garden after the rain, the children were intrigued. The teachers could have prohibited exploration but instead chose to guide the children safely, explaining the dangers of eating mushrooms and providing tools like magnifying glasses and clamps for closer observation. The teachers remained nearby to assist and answer questions, ensuring a valuable learning opportunity was not missed. The cooperation between teachers and families was also crucial in creating quality outdoor play experiences. Families contributed by improving outdoor structures and resources. Parents often volunteered their skills and time to build or repair play structures, such as tree houses and benches, or to gather everyday objects for the children to use, such as kitchen supplies for soil and water play (Bento & Dias, 2017).

TECHNOLOGY INCORPORATED

In 14 kindergarten classrooms in Ontario, open-ended tablet applications were used to support outdoor play and learning. The children created slideshows with photos, videos, drawings, and audio recordings to explore their physical and creative activities outdoors and their connections to nature. Using the tablets' photo and video features, they documented a wide range of creative activities and captured their personal interests in the natural environment. They took pictures and videos of plants, insects, animals, and the weather, and made audio recordings of natural sounds like rustling leaves. This documentation was later brought inside for reflection by both the children and educators, offering insights into the children's interests and thoughts about nature. In one notable instance of dramatic play, a child combined imaginative play with video creation, addressing a future audience as she narrated an adventure in an imagined "scary" and "creepy" forest while walking in a wooded part of the school playground. She used a dramatic voice to engage the viewer and concluded with a rhetorical question about the journey. Initially, teachers were concerned about the safety and the potential for solitary and sedentary use of the tablets. However, the findings showed that the children used the tablets safely, both individually and collaboratively, alongside active outdoor activities like climbing and dramatic play. Instead of detracting from the active, social, and nature-focused aspects of outdoor play, the use of open-ended apps enhanced these experiences by enabling children to document, review, and engage more deeply with their outdoor interests and activities (McGlynn-Stewart et al., 2020).

Connecting Outdoor and Indoor Experiences in ECE

As some of the examples show, connecting outdoor and indoor experiences in Early Childhood Education can create a more holistic and engaging learning environment for children. This connection is also visible in the IBL process described in chapters 1 and 2: the wonder experienced outdoors can be further explored, reflected and registered indoors, or the ideas developed indoors can be tested and experimented on outdoors.

Here are some other ways to foster this connection:

Bring the outdoors inside
Nature displays: Create displays of natural materials like leaves, flowers, stones, and shells. Indoor gardening: Plant seeds and watch them grow indoors. Nature-themed art projects: Use natural materials like leaves, twigs, and flowers for creative projects. Loose parts play: Natural materials are excellent loose parts to foster play.

Extend outdoor learning indoors

Storytelling: Read stories about nature and discuss the themes and characters.

Role-playing: Pretend to be animals, plants, or weather elements.

Puzzles and games: Use puzzles and games with nature-themed images or create them with natural materials.

Explore the connection between indoor and outdoor spaces

Window watching: Observe the weather and natural phenomena from inside and compare with the experience outside.

Build a model: Create a model of a natural environment like a forest or a beach. The playground is also a good option as children can deepen their understanding of representation of spaces by modelling a familiar one.

Discuss the impact of human activities: Talk about how our actions affect the environment both indoors and outdoors.

Encourage children to reflect on their experiences

Journaling: Have children talk and draw about their outdoor and indoor experiences. Record videos of these reflections.

Discussions: Facilitate discussions about the similarities and differences between indoor and outdoor settings. Deepen children's preferences and subjective experiences of both settings.

Create a seamless transition between indoor and outdoor spaces

Open-ended play: Allow children to move freely between indoor and outdoor areas.

Natural materials: Incorporate natural materials like wood, stone, and plants into both indoor and outdoor spaces.

Consistent routines: Establish predictable routines that include both indoor and outdoor activities.

IBL: Support children in starting and developing IBL processes about outdoor experiences or observations.

By connecting outdoor and indoor experiences, early childhood teachers can help children develop a deeper understanding of the natural world and their place in it. This can foster a lifelong appreciation for nature and a sense of environmental responsibility.

Promoting Computational Thinking and Educational Robotics in Nature

Computational thinking involves problem-solving, pattern recognition, and algorithmic thinking. Educational robotics offers a hands-on approach to learning these skills. By combining these two elements in a natural setting, early childhood teachers can create engaging and meaningful learning experiences for young children. It is one area where the connection between outdoors and indoors becomes relevant as many of the robotics activities won't work in the outdoors (particularly floor robots) but others gain pertinence like using sensors for measuring temperature and humidity.

Here are some strategies to promote computational thinking and educational robotics in nature settings.

Nature-based challenges
Create obstacle courses: Use natural materials like rocks, logs, and plants to design obstacle courses that children can navigate as if they were robots. Implement scavenger hunts: Design scavenger hunts that require children to use their robots to find hidden objects or solve puzzles related to nature. Build natural structures: Encourage children to build structures with natural materials like twigs, leaves, and stones, and then programme their robots to interact with these structures.

Environmental data collection
Collect data: Use sensors (attached to robots or stand-alone) to collect data about the environment, such as temperature, humidity, or light levels. Connect this experience with magnifying glasses and microscopes to see small animals and insects. Discuss the power of technology to learn about nature. Analyse data: Help children analyse the collected data and identify patterns or trends. Create visualisations: Use simple tools to create visualisations of the data, such as graphs or charts. Take them outside to connect representations with reality.

Nature-inspired programming
Programme animal movements: Create animations in Scratch Jr. that simulate the movements of animals found in the natural world, such as butterflies, birds, or turtles. Explore nature-inspired robotics: Learn about robots inspired by nature, such as biomimetic robots or the Bee-Bot, and discuss their applications.

Storytelling and imagination
Create nature-based stories: Develop stories that incorporate robots and natural elements. Add elements to video or photo records made while in the outdoor spaces. Encourage imaginative play: Let children use their robots to create their own stories and adventures in the natural world. Explore nature-based myths and legends: Discuss nature-based myths and legends with children and explore how they can be related to robotics.

Outdoor robotics workshops
Organise workshops: Conduct outdoor robotics workshops where children and families can learn together basic programming concepts and experiment with different types of robots.

By implementing these strategies, early childhood teachers can provide children with a unique and engaging learning experience that combines the excitement of robotics with the beauty and wonder of the natural world.

(see also Chapter 4 - Educational robotics and eco-friendly attitudes and behaviours of the GREENCODE Handbook)

Conclusion and Takeaways

Based on these examples and numerous investigations, it is possible to identify different practices that can be developed to promote a greater connection with nature and its protection, as well as greater ecological awareness. Some main ideas to take away:

- Give children time for direct engagement with nature and immersion in natural areas, allowing them to encounter nature at their own pace, following their own interests, becoming comfortable and competent in nature and feel kinship with other living things.
- Let children know that there are many ways to be a "nature person", including play and recreation in nature, working the land sustainably, gardening, studying natural history, caring for animals, making art in nature, using technology to care for nature.
- Enable young children to record their observations and experiences through writing, scientific record keeping, arts, technology, etc.
- Organise repeated field trips and walks in natural areas.
- Make available and promote the exploration of natural loose parts and technology by the children and with their families.
- Read and explore books about nature and its protection (e.g. books about plants and animals, as well as unhappiness at seeing animals hurt or plants and animals dying) and books about nature and eco-friendly practices as well as books about scientists and citizens using technology to protect the environment.

MODULE 4

Basic Hands-on Robotics and Coding Activities

Gianluca Pedemonte and Nicolò Monasterio, Scuola Di Robotica

Introduction to Educational Robotics in Early Childhood Education

In recent years, educational robotics has become a fundamental part of teaching strategies, even for preschool children. This innovative approach not only stimulates children's interest in science and technology, but also fosters the development of fundamental skills such as critical thinking, problem-solving, creativity and collaboration. During the early years of childhood, children learn best through play and hands-on exploration, and educational robotics can provide a rich and stimulating context for these learning experiences.

The use of robotics in pre-school and early primary school may seem challenging, but it is accessible and can be implemented easily and effectively through playful, hands-on activities. These activities not only introduce children to the basic concepts of programming and robotics but can also be used to teach important lessons on current issues, such as environmental sustainability.

In this chapter, we will explore three specific educational activities designed for children aged 3 to 7, each of which integrates robotics and programming learning with environmental sustainability topics. The 6 activities are divided into three categories: an unplugged activity (without technology), one using Scratch Junior, and one tinkering activity (a hands-on building activity). These 6 activities are designed to be fun, engaging and accessible, and can be easily adapted to meet the different needs and skill levels of children.

Tinkering Activity: Nature Mascots for Environmental Protection

Learning objectives

- Promote creativity and innovation by using natural materials to build characters.
- Raise children's awareness of the importance of environmental protection and the sustainable use of natural resources.
- Introduce robotics and programming concepts in a playful way using characters created as sprites in Scratch Junior.
- Develop skills of observation and critical analysis of natural materials and their functions.

Materials needed

- Natural materials collected outdoors (leaves, branches, pinecones, stones, flowers, acorns, etc.).
- Construction materials (eco-friendly adhesive tape, glue, scissors, markers, string, etc.)
- Camera or tablet to photograph the creations.
- Devices with the Scratch Junior app installed for programming.

Description of activity

This tinkering activity focuses on creating "Nature Mascots" using natural materials collected outdoors. Children will explore the natural environment, collect sustainable materials and use them to create characters that promote environmental protection. The mascots created will become the protagonists of an interactive story on Scratch Junior. You can also extend this activity by talking about recycling and waste using recycled materials for the composition of the mascots.

PHASE 1: EXPLORATION AND COLLECTION OF NATURAL MATERIALS

1. Outdoor exploration: Take the children outdoors (in the school garden, a nearby park or a safe green area) to explore and collect natural materials. The teacher guides the children in identifying sustainable materials that can be used to build mascots, such as fallen leaves, dry branches, pinecones, stones, and acorns. It is important to emphasise respect for nature by avoiding damaging plants or collecting living materials.
2. Natural materials discussion: After collecting the materials, encourage the children to explore and touch them. Discuss together:

- Origin of material: Where did it come from? (e.g. leaves fallen from trees, dry branches found on the ground).
- Previous use in nature: What was the role of the material in the environment? (e.g. leaves helped the tree to do photosynthesis).
- Possible transformations: How can we transform it into a character? (e.g. a branch can become the body of a creature, leaves can be wings or hair).

PHASE 2: BUILDING NATURE MASCOTS

1. Creative design: Invite children to imagine how different natural materials can be assembled to create a mascot or nature character. Children can draw a sketch before starting to build.
2. Assembling characters: Using the collected natural materials and environmentally friendly building materials (such as eco-friendly tape and string), the children create their own mascots. They can add creative details such as eyes made from pebbles or acorns, mouths drawn with ecological markers, etc.
3. Mascot presentation: Each child presents their mascot to the class, explaining the thought process behind the choice of natural materials and character design. They can also name their mascot and tell a short story about how it contributes to environmental protection.

PHASE 3: DIGITISING MASCOTS AND CREATING STORIES ON SCRATCH JUNIOR

1. Photograph creations: Use a camera or tablet to photograph the nature mascots created by the children. This will make it possible to import the pictures into Scratch Junior.
2. Import mascots into Scratch Junior: Upload photos of the mascots to Scratch Junior and use them as sprites to create an interactive story. Teachers can guide children on how to import pictures and use them in the app.
3. Programming the story of nature: Using Scratch Junior, children programme their mascots to move and interact in a scenario that promotes environmental protection. For example, characters can plant trees, clean up a beach, or educate other characters about the importance of protecting nature.

PHASE 4: SHARING AND DISCUSSION

1. Presentation of interactive stories: Each child or group of children presents their own interactive story created with Scratch Junior. The teachers facilitate a discussion on the various stories, emphasising the environmental protection messages.

2. Final reflection: Discuss with the children what they have learned from the activity, both in terms of creativity and use of natural materials, and in terms of programming and digital storytelling.

EDUCATIONAL BENEFITS

This activity offers an immersive learning experience that combines outdoor exploration, artistic creativity, and technological skills. Children learn the importance of preserving the environment through the sustainable use of natural materials while developing key dimensions of computational thinking, such as problem-solving, decomposition, and algorithmic thinking. They also acquire basic skills in programming and digital storytelling. As children design and create their robots, they practice breaking down complex tasks into smaller steps (decomposition), and they follow sequences of actions to programme their robots (algorithmic thinking). In addition, the activity encourages collaboration and teamwork as children create stories that promote protection and respect for the natural environment.

Tinkering Activity: “The Odd Fish”

Educational objectives

- To promote creativity and innovation using recycled materials.
- Raise children’s awareness of the importance of recycling and environmental sustainability.
- Introduce basic storytelling and digital storytelling concepts using Scratch Junior.
- Develop design and construction skills through tinkering.
- Involve children in the creation of characters and stories, stimulating imagination and digital skills.

Materials needed

- Recycled materials (plastic bottles, caps, toilet paper rolls, fabric, cardboard, buttons, thread, etc.).
- Construction materials (adhesive tape, glue, scissors, acrylic paints, markers, etc.)
- Devices with Scratch Junior installed for digital storytelling
- Camera or tablet to photograph the children’s creations.

Description of activity

This tinkering activity combines artistic creativity, sustainability and digital storytelling. Inspired by the story “The Odd Fish” (Jones, 2022), children will build sea creatures using recycled materials. These creatures will become the protagonists of a digital story, which the children will create using Scratch Junior.

PHASE 1: INTRODUCTION TO STORYTELLING AND SUSTAINABILITY

1. Introduction to the story "The Odd Fish": The teacher tells or reads the story "The Odd Fish", a story about a fish who mistakes a plastic bottle for a fish he has never seen. Being all alone, he decides to help him find his fellow fish. During the journey, they will meet various marine and non-marine "creatures". The story can emphasise marine pollution and the importance of not littering the sea, as well as the possibility of turning waste into useful objects.
2. Discussion on sustainability: After telling the story, the teacher opens a discussion on the themes of the story, such as the importance of taking care of the environment and the ocean. The teacher talks about how we can recycle and reuse materials to reduce pollution.

PHASE 2: MATERIALS EXPLORATION AND ANALYSIS

1. Exploration of recycled materials: The teacher presents a selection of recycled materials collected for the activity, such as plastic bottles, bottle caps, old cloth, boxes, etc. and presents them to the children. Then the teacher invites the children to explore the materials, touch them and imagine what they could become.
2. Analysis of materials: Discuss with the children:
   - Previous use: What was this object before? (e.g. A plastic bottle was used to hold water).
   - Possible transformation: What could it become? (e.g. the plastic bottle could be transformed into a fish or a jellyfish).

PHASE 3: CREATING SEA CREATURES

1. Creative design: Each child chooses a type of sea creature to create using the recycled materials. They can choose from fish, octopus, jellyfish, seahorses, etc. The teacher encourages the children to imagine what their creature could look like using the available materials.
2. Construction of sea creatures: The children begin to build their own creatures using the recycled materials. They can use tape, glue, colours and other tools to decorate and customise their creatures. For example, a toilet paper roll could become the body of an octopus with arms made of fabric strips.
3. Presentation of creatures: Once the creations have been completed, each child presents their creature to the class, explaining what materials they used and why. They can also name their creature and describe a little of its "personality" or "role" in the sea.

PHASE 4: DIGITISING THE CREATURES AND STORYTELLING ON SCRATCH JUNIOR

1. Photographing the creatures: Use a camera or tablet to photograph the sea creatures created by the children. These photos will be used as sprites in Scratch Junior.
2. Import the creatures into Scratch Junior: Upload the pictures of the creatures to Scratch Junior and turn them into sprites. The teacher shows the children how to import the pictures and how to use them within the app.
3. Creating the digital story: The children, with the support of the teacher, use Scratch Junior to create a digital story involving their sea creatures. They can create a scenario in which the creatures have to clean up the sea, help other animals find safe havens, or other sustainability-related adventures.
4. Movement and interaction programming: Children programme the movements of their creatures using Scratch Junior blocks. They can programme the creatures to move, talk (using text or voice recordings), interact with each other, or pick up litter objects in the digital environment.

PHASE 5: SHARING AND DISCUSSION

1. Presentation of digital stories: Each group or child presents their digital story to the class. The stories can be projected on a large screen or shared directly on a tablet.
2. Final discussion: The teacher leads a final discussion on the themes explored in the stories. Discussions can be held on how sea creatures could further contribute to sustainability, or other creative ideas for recycling and reusing materials.
3. Reflection: The children reflect on the activity, what they have learnt and how they could apply these lessons in their daily lives.

EDUCATIONAL BENEFITS

This educational tinkering activity combines creativity, sustainability and digital skills, offering children an engaging and multidisciplinary learning experience. Children develop design and construction skills, learn the importance of recycling and reuse, and acquire basic skills in programming and digital storytelling. In addition, the activity promotes critical thinking, collaboration and communication, encouraging children to reflect on their actions and general environmental impact.

Activities with Scratch Junior – "Digital Recycling"

Learning objectives

- Introduction to the basic concepts of visual programming through Scratch Junior.
- Promote environmental awareness and teach children the importance of separate waste collection.
- Develop language and communication skills by recording and using their own voices in the context of an educational game.
- Involve children in a collaborative process of programming and story creation.

Materials needed

- Tablets or devices with the Scratch Junior app installed.
- A quiet environment to record the children's voices.
- A set of sprites representing different types of waste (paper, plastic, glass, organic, etc.) already prepared by the teacher.

Activity description

This activity uses Scratch Junior to create an educational game in which children learn about the importance of recycling. Children will choose different sprites representing various types of waste and "dispose" of them in the correct bin through a process guided by the teacher and using visual programming. The children's voices will be recorded to make the activity more interactive and personalised.

PHASE 1: INTRODUCTION TO THE GAME AND PREPARATION OF THE SPRITES

1. Introduction to the theme of separate collection: The teacher starts the activity with a brief explanation of the importance of separate collection and how we can contribute to a cleaner, more sustainable environment. Concrete examples can be used (what goes in the plastic bin, what goes in the organic bin, etc.).
2. Sorting sprites: Using Scratch Junior, the teacher shows different sprites representing different types of waste (e.g. a plastic bottle, a piece of paper, an eaten apple for organic waste, a glass jar, etc.).
3. Children's choice of sprites: Each child chooses one or more waste sprites that they would like to use in the game. The teacher can ask questions to help the children think about the type of waste and disposal in the right recycling bin.

PHASE 2: RECORDING CHILDREN'S VOICES

1. Recording voices: After choosing the sprites, each child records his or her voice using the tablet or device with Scratch Junior. The recordings will include phrases such as:
   - "This is a piece of paper; it goes in the paper bin".
   - "This is a plastic bottle; it goes in the plastic bin".
   - "This is an apple core; it goes in the organic bin".
2. Linking voices to sprites: The teacher helps children link audio recordings to the appropriate sprites in Scratch Junior. This makes the game interactive and personal, as the children hear their own voices as they play.

PHASE 3: PROGRAMMING THE GAME

1. Programming the movement: The teacher shows/guides the children in programming the movement of the sprites. Using the Scratch Junior blocks, the sprites are to be "dragged" or "carried" to the correct bin:
   - Movement block (forward, backward, up, down) to move the sprite.
   - Tracking block to know when the sprite reaches the correct bin.
   - Sound block to play the recorded sound when the sprite is positioned correctly.
2. Testing and debugging: The teacher and children test the game to ensure that each sprite moves correctly and that the correct sound is played when the sprite reaches the correct bin. In the event of errors, the teacher shows the children the debugging process (error correction).

PHASE 4: PLAYING AND SHARING

1. Game: The children play individually or in small groups, trying to correctly dispose of all the waste in the game. Each time they correctly dispose of an item, they hear their own voice confirming the type of waste and the correct bin, reinforcing the concept of waste separation.
2. Final discussion: After playing the game, the teacher facilitates a discussion on the lessons learned during the activity and asks the children which waste was easy or difficult to dispose of correctly and why. The discussion can also touch on topics such as waste reduction and other sustainable practices.
3. Sharing the game: If possible, the game can be shared with other classes or parents, to show what the children have learnt and how they can educate others about waste separation.

EDUCATIONAL BENEFITS

This educational activity on Scratch Junior helps children develop a fundamental understanding of visual programming and digital skills in a playful context. Using a sustainability theme, children not only learn about the importance of recycling, but do so in an interactive way, using their own voices to create a personalised learning experience. In addition, the activity reinforces problem-solving and collaboration skills as the children work together to plan and refine their educational game.

Unplugged Activity: Sustainable and Unsustainable Actions

Educational objectives

- Introduction to basic concepts of sustainability through everyday actions.
- Develop the ability to recognise sustainable and unsustainable behaviour.
- Introduce the basic concepts of unplugged programming, such as sequences and conditions.
- Stimulate creativity and teamwork through the creation of customised playing cards.
- Foster critical thinking and decision-making skills in children.

Materials needed

- White card for playing cards.
- Markers, coloured pencils, stickers to decorate the cards.
- A large sheet of paper or coloured tape to mark out two zones on the floor: a “sustainable zone” and an “unsustainable zone”.
- Paper arrows or visual programming blocks (such as directional arrows) to programme movements.
- Bag or box to shuffle and draw out playing cards.

Description of activity

This unplugged activity introduces children to the concept of sustainability, encouraging them to distinguish between positive and negative actions for the environment. Children use their creativity to design playing cards and participate in an unplugged programming activity to “sort” sustainable and unsustainable actions into appropriate areas of the classroom.

PHASE 1: INTRODUCTION TO THE TOPIC

1. Initial discussion: The teacher introduces the concept of sustainability, explaining that it means taking care of our planet by making good choices for the environment. The teacher can use simple, concrete examples, such as "use less plastic" or "turn off lights when they are not needed".
2. Introduction of sustainable and unsustainable actions: The teacher lists some actions that can be sustainable or unsustainable.

Examples of sustainable actions include:

- Cycling or walking to school.
- Sorting rubbish.
- Turning off the water while brushing one's teeth.

Non-sustainable actions might include:

- Leaving lights on when not needed.
- Using the car for short distances when you could walk.
- Throwing plastic in the waste bin instead of recycling it.

PHASE 2: RECOGNISING POSITIVE AND NEGATIVE ACTIONS

1. Practical examples: The teacher shows pictures or describes situations and asks the children whether they think the action is positive (sustainable) or negative (unsustainable) for the environment. The children raise their hands and explain their answers.

PHASE 3: CREATING PLAYING CARDS

1. Drawing the cards: Each child chooses an action (sustainable or unsustainable) and draws it on a white card. The children can customise and colour their cards, making them unique. For example, they can draw a child riding a bicycle for a sustainable action, or an open tap with water running unnecessarily for an unsustainable action.
2. Preparing the playing cards: Once all the children have completed their cards, the teacher collects them and places them in a bag or box to be shuffled.

PHASE 4: DEFINE THE ZONES OF SUSTAINABILITY

1. Preparing the class: The teacher prepares the class by creating two zones on the floor: a "sustainable zone" and an "unsustainable zone". The zones can be marked out with coloured tape or a large sheet of paper.

PHASE 5: CARD GAME AND ACTION SORTING

1. Drawing out a card: Each child, in turn, draws out a card from the bag and shows it to the class.

2. Determining whether the action is sustainable or unsustainable: The child who draws out the card decides whether the action depicted is sustainable or unsustainable and explains his or her decision to the others. The teacher can ask questions to deepen understanding.

PHASE 6: UNPLUGGED PROGRAMMING

1. Programming movements: Using paper arrows or visual programming blocks (forward, backward, turn right, turn left), children programme the movements necessary to bring the action represented by the paper to the correct zone ("sustainable" or "unsustainable").
2. Performing the movement: One child will be "programmed" to follow the instructions of the other children to bring the card to the appropriate zone. Children can work in pairs or small groups to programme the movements of their peers.

PHASE 7: FINAL DISCUSSION AND REFLECTION

1. Discussion and conclusion: After all the cards have been sorted, the teacher facilitates a discussion on what the children have learnt. The class can discuss how they felt during the activity and what actions they can take in their daily lives to be more sustainable.
2. Reflection: The children can reflect on other actions that could be added to the game in the future or how they could improve their cards.

EDUCATIONAL BENEFITS

This unplugged educational activity offers a multidisciplinary approach to teaching sustainability, combining art, basic programming, and critical thinking. Children learn to recognise sustainable and unsustainable actions, develop simple programming skills, and practise communication and teamwork. In addition, the activity stimulates creativity and encourages children to reflect on their daily actions and the impact they have on the environment.

Robot Sensors Emulate Human Senses

Learning objectives

- Foster understanding of the relationship between robot sensors and human senses.
- Encourage children to explore and connect sensory experiences to robotics.
- Promote creativity by designing simple "robots" using natural or household materials.

- Introduce basic robotics and programming concepts in a playful, unplugged activity.

Materials needed

- Natural materials or simple household items (leaves, branches, cotton balls, plastic cups, foil, etc.)
- Craft materials (glue, scissors, markers, string, eco-friendly tape)
- Flashlights, small mirrors, bells, and objects with different textures (e.g., sandpaper, fabric)
- Large paper or whiteboard for drawing
- Optional: Pre-made robot figurines or simple robotic toy

Description of activity

In this activity, preschool children will explore how robot sensors are like human senses. They will first engage in sensory experiences (sight, hearing, touch) to understand how we use our senses to interact with the world. Then, they will compare these to robot sensors (light sensors for eyes, sound sensors for ears, and touch sensors for skin). Children will create robots using natural or household materials, with each robot representing a specific sensor. The activity also includes a roleplay game, where children act as robots, navigating an obstacle course using their "senses" to move and interact with objects, mimicking robot functions. This activity introduces basic robotics concepts while fostering creativity, problem-solving, and a deeper understanding of both natural and technological systems.

PHASE 1: EXPLORING HUMAN SENSES

1. Start by asking the children about their senses. "What do we use to see? Hear? Smell? Touch?"
2. As the children give answers, let them try simple sensory experiences:
   - Sight: Use a flashlight to shine light and reflect it on a mirror.
   - Hearing: Ring a bell and ask the children to close their eyes and point to where the sound is coming from.
   - Touch: Let children feel objects with different textures (rough, smooth, soft, hard).
   - Smell: Offer natural objects like flowers or leaves for smelling.
3. Discussion: Explain how our senses help us understand the world. Just like our eyes see light, our ears hear sound, and our skin feels different surfaces, robots use sensors to "see", "hear", and "feel" things around them.

PHASE 2: INTRODUCING ROBOT SENSORS

1. Introduce robot sensors by showing simple illustrations or objects resembling robots.

2. Explain that robots don't have eyes, ears, or noses like us, but they have "sensors" to help them "see", "hear", or "touch".
   - Light sensor as eyes: Explain that robots use light sensors to detect brightness, just as we use our eyes to see light.
   - Sound sensor as ears: Robots can "hear" sounds using sound sensors.
   - Touch sensor as skin: Robots can have touch sensors to feel when they bump into things, similar to how we feel something when we touch it.

PHASE 3: BUILDING "ROBOT SENSES" FROM NATURAL OR HOUSEHOLD MATERIALS

1. Invite children to create their own "robots" using natural materials (leaves, branches) or household items like cups, foil, and string.
2. Children will add parts to represent each of the robot's "senses":
   - Eyes (light sensor): Use shiny materials like foil or mirrors to represent robot "eyes".
   - Ears (sound sensor): Small bells or cups can represent ears.
   - Hands (touch sensor): Add textured items, like leaves or soft fabric, to show how the robot "feels" things.
3. Naming and presentation: Let each child name their robot and explain which materials represent its sensors (eyes, ears, hands). For example, "This is Robo, and it can see with its shiny foil eyes and hear with its bell ears!"

PHASE 4: UNPLUGGED PROGRAMMING GAME – "SENSES IN ACTION"

1. Set up a simple obstacle course in the room. Ask the children to pretend to be robots with different sensors.
   - Robot with light sensors (Eyes): Children can only move when the flashlight is on. When it's off, they must stop.
   - Robot with sound sensors (Ears): Children move when they hear the bell ring and stop when it's silent.
   - Robot with touch sensors (Skin): Children need to feel a specific object (e.g., soft fabric or hard cardboard) before they can proceed to the next step.

2. Discussion: After the game, ask the children how their "robot senses" helped them move and explore. How did they know when to go or stop? How did the flashlight or bell help them, like a robot's sensors would?

PHASE 5: FINAL REFLECTION AND DISCUSSION

1. Gather the children and ask them what they learned about senses—both their own and the robot's sensors.
2. Help them reflect on how robots use sensors just as we use our senses to interact with the world.
3. Optional: Discuss how robots can help us in real life—like cleaning, finding things, or even exploring space!

EDUCATIONAL BENEFITS

This activity connects abstract concepts like robot sensors to everyday sensory experiences, making the introduction to robotics and programming more relatable and hands-on. By engaging in sensory exploration and creative building, children develop problem-solving skills, critical thinking, and a deeper understanding of how technology mimics natural systems. The unplugged programming roleplay introduces basic robotics and coding concepts without the need for advanced technology, keeping the activity accessible and engaging for preschool learners.

Conclusions

The integration of robotics and coding into Early Childhood Education offers a unique and impactful approach to developing both cognitive and social skills. Based on the activities presented in this module, several key conclusions can be drawn.

The introduction of educational robotics and coding in Early Childhood Education effectively enhances essential skills such as problem-solving, critical thinking, creativity, and collaboration. These hands-on and playful learning activities, specifically designed for young children, help introduce fundamental concepts in robotics and programming while also engaging children in important discussions around real-world issues, like environmental sustainability.

By integrating sustainability topics into robotics and coding activities, the module demonstrates a holistic educational approach. Activities like "Nature Mascots for Environmental Protection" and "The Odd Fish" encourage children to engage with the natural world, teaching them about the importance of environmental conservation while simultaneously developing their technological skills. These activities highlight how combining nature with technology fosters a deeper understanding of sustainability from an early age.

Also, this module outlines how tinkering and digital storytelling through tools like Scratch Junior can create immersive learning experiences that combine artistic creativity, sustainability awareness, and programming skills. These activities offer children a chance to express themselves creatively while also fostering teamwork, problem-solving, and communication. This multidisciplinary approach nurtures cognitive and social development, making learning both engaging and meaningful.

MODULE 5

The Role of Evaluation and Documentation in ECE in the IBL Approach

Mary O'Reilly and Noletta Smyth, Early Years - The Organisation for Young Children Roi

The Importance of Documentation, Assessment, and Evaluation

In preschool an Inquiry-Based Learning approach focuses on the children leading the process themselves (See Module 1 for in-depth study of IBL). Children become active learners as they:

- choose which topics to explore.
- research these topics.
- decide what to produce,
- create, or solve problems.
- and then reflect on what they have learned.

High quality documentation and assessment ensures teachers are noticing what learning is occurring for the children at every step of the IBL approach cycle and linking it to curriculum and relevant theories. It is an important part of supporting children throughout their IBL learning journey.

Once a teacher has documented and assessed what learning is taking place, they're able to plan opportunities to extend the child's learning and development.

Rich assessment is an effective way to share and provide feedback on the child's learning journey with their parents/carers and gives the child an opportunity to reflect on their learning over a period of time. Regular feedback to and from families and other teachers ensures a holistic picture of individual children's learning and development is gathered.

Documentation is putting into words, photos, pictures, videos, drawings, recordings, and artefacts the story of the child's learning process – in partnership with the children themselves. This deepens and transforms the learning itself, adding another layer of complexity to the work of children.

A central feature of the Reggio Emilia approach is extensive documentation through observation, reflection, and analysis by teachers of children's development and behaviour. Documentation records the experiences of children in the classroom.

Documentation, therefore, is seen as visible listening, as the construction of traces (through notes, slides, videos and so on) that not only testify to the children's learning paths and processes, but also make them possible because they are visible. For us this means making visible, and thus possible, the relationships that are the building blocks of knowledge (Rinaldi, 2001).

Some important learning for us regarding documentation from the Reggio Approach is:

- Rather than documenting finished products, we must try to document children's learning processes.
- Documentation is only useful when constantly revisited, discussed, and reflected upon.
- Documentation should add value to learning experiences and inform future planning.
- Documentation can be used to show the collective experiences of children.
- Documentation can be used as a reflective tool for children themselves and for adults to engage in reflective interviews with children – revisiting their experiences by looking at photos, videos and discussing these with other children.
- Documentation can enable children to come up with new theories and ideas to carry out their research.

"Rich documentation incorporates multiple perspectives, including the voices of children, educators, peers, families and other professionals" (ACECQA, 2022).

Assessment is the process of gathering information about children's learning and performance and evaluation is the process of interpreting that information and making judgments about what has been learned. Both are relevant in achieving a complete picture of the child's learning processes throughout the IBL cycle.

Throughout each step of the IBL approach, it is important for teachers to observe and document how children are interacting and learning from each other. Social interactions among children and children and adults are essential for overall wellbeing and happiness. We know that children who have multiple opportunities to interact with their peers develop better communication skills, problem-solving and conflict resolution skills as well as developing their emotional intelligence, creativity and resilience.

Therefore, the teacher must be open to adapting the documentation to reflect how group dynamics change as children join different groups during the different steps of the IBL cycle and assess how their social skills are developing. Self-observation and assessment can also come into play here when individual and/or groups of children watch a video clip together for example, when they can learn from each other's reflections and interpretations of what took place.

Another consideration is to remember that there is not only one way to assess and evaluate learning. Children have multiple ways of learning, and the teacher needs to observe children carefully to get to know their different learning styles and intelligences. The similarities and connections between the "Hundred Languages of Children" conceived by Loris Malaguzzi, Reggio Children and Howard Gardner's theory of multiple intelligences must influence the way we view and respect children's learning processes within our preschools.

The Universal Design for Learning principles (2014) further illustrates and reinforces the need to improve learning by making it accessible for all learners whatever their innate learning preferences and abilities.

- Multiple means of engagement. For purposeful, motivated learners, stimulate interest and motivation for learning.
- Multiple means of representation. For resourceful, knowledgeable learners, present information and content in different ways.
- Multiple means of action and expression. Differentiate the ways that learners can express what they know.

In Sir Ken Robinson's TED Talk "Do schools kill creativity?" (TED, 2006), he argues that schools often prioritise academic and intellectual achievement at the expense of other forms of intelligence, such as artistry or musicality. "Learning happens in the minds and souls, not in the databases of multiple-choice tests".

Methods and Tools for Assessing Learning Outcomes in Early Childhood Education

Observations are the most used methods and tools used in ECE for assessing learning outcomes in preschool. Observation is part of the cycle - observation, assessment, and planning - which most Early Years teachers are familiar with.

This process generally follows a similar pattern no matter where in the world your preschool is (see Figure 5.1)

Figure 5.1

The observation, assessment and planning process

Note. Adapted from *Working with the Revised Early Years Foundation Stage*, by J. Grenier, 2021.

This process can be used at each step of the IBL cycle. Each step is equally important, and we may sometimes repeat steps before moving on to the next one. The cycle is ongoing rather than ending at one point. We may need more than one observation before we make an assessment, we might plan learning opportunities to find they didn't capture what we wanted so we need to plan something different. This observation-assessment-planning cycle can also be usefully extended by thinking about the importance of feedback and scaffolding. Whilst some observations are written down, analysed, and acted on in planning, there is a second, more powerful and more immediate cycle. That's when teachers notice something about what a child is doing, or saying, and they give the child helpful feedback there and then (Grenier, 2021).

Helping children to reflect on their learning and to refine key skills is much more important than writing things down and giving them a level. By showing our confidence that they can keep getting better when they try hard and persevere, we reinforce the important idea that we don't have "fixed" abilities. We can all get better at what we do if we get the right support, encouragement, and help. Effort matters (Grenier, 2021).

Observation is about much more than describing what a child does. It means really watching and listening, being aware of the child's actual development, recognising what interests, motivates and engages them, and then reflecting on what these observations tell us about the child's learning.

There are various ways of observing children at play and reflecting on its meaning. This might be through quietly watching the play and gathering thoughts through writing or taking a sequence of photos, while consciously thinking about what the children are doing and why. Photographs must be annotated to explain what they are showing. Again, remember this needs to be done factually, photos are just another way of collecting that evidence. Teachers also appreciated how they could share observations immediately with parents by using digital documentation software (Flewitt & Cowan, 2020).

One positive outcome from the Covid pandemic enabled the more prevalent use of digital documentation between teachers and parents/carers. However, this evolution and widespread use of digital technologies has also raised further issues to critically reflect on, such as the impact of devices on meaningful interactions and respect of children's rights (Livigstone, 2019).

Are you capturing the child's "voice"? This can mean writing word for word what the child says, or for younger children describing clearly how they make their wishes known, or what they were doing. Photos and examples of children's work are another great tool.

Observing doesn't need to be time consuming. A great way to collect snapshot observations is on "post it" notes. Have a pack in your back pocket and a pen to hand and when you see something you want to observe simply note it down. The post it notes can then be stuck into the child's learning folder later. There is no need to re-write the observation. In this way you can easily take observations as part of your daily routine for both your key children and your colleagues without the need to remove yourself from the care of the children.

Whilst observing children you will watch their actions, behaviours, interactions, and expressions. Sometimes you will just listen and other times you will join in and talk to them. Observation forms a vital part of the assessment and planning cycle.

Before starting any observation, you should consider your reasons for carrying out the observation, so that you can capture the most useful information. Teachers need to have a deep understanding of child development and their own countries' preschool curriculum.

Observations should be carried out when the child is engaged in a freely chosen activity. You will learn much more about a child's interests, their characteristics of learning, and their abilities when they are engaged in something they have chosen to do, rather than during a set or planned activity.

The High Scope Approach (highscope.org) uses the term "authentic assessments" which includes a range of tasks to observe, document, evaluate and continually strive to improve interactions with children, families, and co-workers and to assess children's active learning experiences. The approach has an online Child Observation Record (COR) which compiles individual child assessments against the curriculum content identified in the Key Developmental Indicators (KDIs).

The Irish Curriculum Aistear Siolta (aistearsiolta.ie) practice guide shares key tips looking at some examples of documentation that are effective, but that don't take too much time on a busy day. These methods can be used with all age-groups – and ensure that children's learning is visible. For example: A webbing format. This web type template means that you can jot down simple ideas as they happen. Later, you can reflect and discuss how to support this interest further, as well as adding a few photographs of what happened.

The Learning Stories Assessment approach is a form of observation and documentation that is written in a narrative story format. The teacher watches and listens as children explore through play (Carr, 2001) describes this way of assessment as staying close to the children's real experiences and providing an alternative to mechanistic and fragmented approaches. Learning Stories show how practitioners can assess what really matters: those learning dispositions (interest, involvement and perseverance for example) that provide a foundation for life-long learning. Learning Stories are about weaving theory and practice.

Read Dr Christina Egan Marnell's blog for how she uses Notice-Recognise-Respond framework to structure her learning stories (Marnell, 2023).

"Inquiry-Based Learning with Dr Claire Warden" podcast explores at length how this pedagogy of learning needs to be part of the ethos of the preschool centre – she discusses the benefits of risk, and the importance of instilling curiosity and fascination in children. She illustrates how "Floor books" – Curriculum and Planning Journals can be implemented for planning, guiding the line of inquiry, and documenting children's learning. Nature pedagogy is the way forward for all of us – Her new book "Green Teaching: Nature Pedagogies for Climate Change & Sustainability" (Warden, 2022) shows us how to embed green teaching and a nature-based pedagogy in practice.

Adapting Evaluation/Assessment Techniques for Young Learners

Evaluation and assessment can provide evidence of:

- the children's confidence and their interest in the activities provided.
- what has been successful and whether the expected learning has taken place.

- how activities might be changed, adapted, or extended to improve learning or to meet more effectively the needs of individual children.
- how teachers supported and scaffolded the children during play.
- how the ideas of individual children might be built upon and extended.
- how activities might be made more stimulating and attractive to the children.
- how the space and time might be organised more effectively; and
- additional resources that might enhance learning (CCEA, 2019).

As stated, assessment of preschool children should be carried out in a holistic manner to cover all development areas and include skills such as language, motor, self-regulation, and social interactions for individual children as well as groups of children. This will also help to identify any individual needs. The IBL approach steps encourage children to be critical and analytical thinkers, to build on their natural curiosity by asking questions, investigating, solving problems, testing out theories alone and with their peers, challenging others and becoming effective decision makers. Effective assessment needs to capture and build on all of this.

All Children Learning (2019) (a newly developed knowledge platform for assessment in line with SDG 4) identifies some of the challenges in assessing pre-school and school children to include factors such as their short attention spans, the fact that they are likely to be easily distracted and the likelihood that they will perform or behave differently with different people. For example, data collected from observation may depend on who is doing the observation as children will respond differently to a parent, a familiar person, or a stranger. Due to short attention spans, moreover, it is not possible to assess preschool children for large amounts of time, so assessment often must take place in several short periods of time.

The interactive, game-like nature of digital assessment can help to remove the stress of assessment from young children. Therefore, both digital and pen and paper assessment techniques should be considered during the IBL cycle.

"Intentional teaching means teachers act with specific outcomes or goals in mind for children's development and learning. Teachers must know when to use a given strategy to accommodate the different ways that individual children learn and the specific content they are learning" (Epstein, 2007).

However, being deliberate in the planning of teaching opportunities does not mean that intentional teaching is teacher-directed. Indeed, one of the major aspects of this approach is its flexibility so that teachers move in and out of different roles and draw on different strategies as the context changes.

Reflection on gathered evidence of learning can help us decide how we can support the child further throughout the IBL cycle. It is how the information is used to affect children's opportunities and experiences which makes a difference to their learning and development.

1. Planning should be individual to each child, thinking about how we could vary or extend the activity, how we could reinforce the newly acquired skill (children learn through repetition), how we can make use of resources, the local environment and of amenities to further the child's learning, and so on. Assessing progress towards children's personalised goals rather than a one-size-fits-all approach is effective.
2. Planning and the learning intention. You may plan to engage in one-on-one conversations with children and ask open-ended questions related to the activity. For example: "Tell me about what you did when you planted the seeds". "Why do you think sunlight is important for plants?" which will assess their understanding, vocabulary, and ability to express themselves.

For planting seeds, you can assess their ability to follow instructions, handle materials, and care for the plants. You can introduce new vocabulary relating to mathematical concepts (size, weight, big, small). You may plan opportunities for the child: responding to instructions; developing fine motor skills; developing manipulative skills (maybe through filling, pouring, emptying); developing critical thinking (how problems may be solved). You may plan to offer more opportunities to share resources; to take turns, to make choices and decisions and to develop curiosity. With each of these planned "next steps" you should consider the "learning intention" and that will help you to recognise which of the outcome areas of learning and development will, potentially, be progressed. Taking care of plants requires responsibility. Children learn to water, nurture, and protect their growing seeds. This experience fosters a connection to the natural world and helps them appreciate life processes. Children observe seeds as they transform into seedlings. They learn about roots growing downward and shoots growing upward. This process encourages curiosity and exploration. Learning that plants don't grow overnight teaches patience. Children observe the gradual process from seed to sprout to mature plant. Starting with quick-growing plants like cress heads provides a tangible experience of growth.

It is important that we recognize the child's own interests and include the child's own ideas. This planning might include a visit to a vegetable garden, reading books, singing songs and rhymes about plants, or providing creative opportunities such as painting and junk art activities.

In the most effective preschool settings teachers support and challenge children's thinking by getting involved in the thinking process with them. They use provocations, tools, resources, documentation, and dialogue to deepen, extend and sustain learners' interests. They plan specific interactions and challenges to extend children's capabilities and higher order thinking skills (Aussie Childcare Network, 2022).

Sally Featherstone (2008), in "Like Bees not Butterflies", gives good advice on adapting assessment techniques for young children:

- plan time for assessment – if you don't plan for it, you won't do it!

- use post-it notes for little jottings. Date them, but don't feel you have to copy them up in "best".
- use other adults to help with the notes and observations.
- give yourself a bit of time at the end of focus sessions to sit back, observe and make a few notes.
- start involving children in assessing their own performance and success.
- work with your TA to share the load - one leads a session, the other observes.
- keep a notebook with you when children are investigating, playing, selecting their own activities.
- focus on a few children each day, so you can get some in-depth information.
- take lots of photos - digital cameras/phones are a MUST - and get the children used to photographing their own work.
- photocopy children's work (written on white boards etc).
- get used to looking for "significant" achievements (those which surprise you, delight you or confirm what you thought was happening).
- always date and annotate items you put in the children's folders.
- use the curriculum statements often, so you get to know them well.
- don't try to observe too many things at once but be prepared to recognise learning that you didn't plan or expect!

Teachers need to reflect on what they know about children and use this knowledge to:

- plan to meet the child's needs, perhaps through adjusting styles of interaction, introducing new experiences, changing routines, or rearranging the environment
- plan to support learning, through offering linked opportunities to practise and consolidate, following up on identified interests, or extending observed learning in a specific area
- share insights with parents/carers, enabling them to work together with practitioners to support the child's learning
- share information with other settings the child may attend, so both partners can better meet the child's needs and support learning.

By using what we know about the child through written records, photographs, and films we can interpret what the child is doing. This important process involves us thinking about what we have seen and striving to make sense of it, helping us to figure out and gain insight into how and what a child is learning. Our interpretations are likely to be subjective, based on our own personal knowledge of child development, cultural background, relevant curriculum, and our understanding of what we observe. Having regular opportunities to discuss our observations with colleagues will help us to think more deeply about our unconscious biases (Louis, 2022).

MODULE 6

Inquiry-Based Learning Approach: a Step-by-Step Guide

Recommendation for teachers: To support the Inquiry-Based Learning approach for preschool-aged children, it's essential to create a structured yet flexible environment where children feel encouraged to explore, ask questions, and reflect on their learning. Providing hands-on experiences, encouraging curiosity, and facilitating discussions are key. Each step in the inquiry process builds a foundation for the next by gradually increasing the complexity of the tasks and deepening the children's understanding (see Table 6.1).

Table 6.1
IBL approach guide, step by step (examples)

Steps and actions		Teachers' role	With robotics	With nature	Robotics and nature combined approach
ENGAGE	OBSERVING	**Directs and guides** the process	Begin by showing children a simple robot (like a Bee-Bot) and **let them watch it move**. Ask questions like, "What do you notice about how the robot moves?" or "What parts of the robot move?", "What	Begin by **taking children on a walk** through a natural setting, such as a garden or park. **Encourage** them to observe different elements like plants, bugs, and weather conditions. Ask questions like, "What do you notice about the plants	Children **explore the natural environment** and **study living creatures** such as animals, birds, and insects. For example, study ants' movements, then simulate their behaviour with robots. Introduce the concept of **robotic sensors**.

			makes the robot move?" to **spark curiosity.**	here?", "How many kinds of insects can you see?" or "How do insects **help the environment**?"	
	DESCRIBING	Directs and guides the process. Helps to formulate a central **research question based on children's previous activities and interests**.	Encourage children to describe the robot's features such as colour, shape, and size. **Let them use their own words** to express what they see, promoting their observational and descriptive skills.	Have children **describe what they see** in their own words, using drawings or simple descriptions. They can note the colours, shapes, and sizes of leaves, flowers, or insects, fostering their observational and descriptive skills.	After exploring ants, learners **try to describe** how ants move, their observations on ants' paths and others. **Engage** with questions such as: Are their paths straight? Do they avoid obstacles? Do they need to be cautious of anything? It can help children to find answers to visible-observable things in nature.
INVESTIGATE	**QUESTIONING**	**Encourage and support** further questioning and investigation.	**Guide children to ask questions** about the robot's functionality. For example, "What do you think this button does?" or "What will happen if we change this part?"	**Guide children to ask questions** about natural phenomena. For instance, "Why do you think this plant has wilted leaves?" or "What happens to the pond when it rains?" "When we observed the ants, we saw them carrying food back to their nest. **What do you think** would happen if the area around their nest became too dry or was covered in trash?	After exploring an ant's movements, learners can **pose further research questions** such as "What do ants carry?" "Why are ants necessary?" "What contributions do they make to nature and the planet?" etc. **Discuss** how robotic sensors mimic biological sensors in ants. "We learned that ants use their antennae to sense things like food or obstacles in their path. Now, look at our robot. It has sensors that help it detect objects and avoid hitting them. How do you

				How would that change the way the ants behave?" This encourages critical thinking about nature and environmental effects.	think these robot sensors are like the ants' antennae?"
	COMPARING	**Facilitate the comparison** and integration of new knowledge with prior knowledge.	After children have explored the robot, **ask them to compare** it with objects or toys they are familiar with. Questions like "How is this robot like/not like your toy car?" help integrate new knowledge with existing understandings.	After children have explored the natural elements, **encourage them to compare** them with other objects or scenarios they know. For example, "How is this flower like/not like the one we saw last week?" This helps integrate new environmental knowledge with what they already know.	Children **research using various resources**, including simple texts, children's encyclopaedias, videos, and natural history museums etc. They compare and contrast information and may raise additional questions such as "Are all ants the same?" "How do they differ?" **Discuss** "Ants use their sensors to help them find food and work together with other ants. How do the robot's sensors help it complete its tasks?
	PREDICTING	**Support** children in making predictions and discussing their hypotheses.	Before experimenting with the robot, **ask children to predict** what will happen if they perform certain actions, such as pressing a specific button or setting the robot to move towards a barrier.	Before any changes are made in the garden or observed area (like planting new seeds or changing the landscape), **ask children to predict** what they think will happen. This could be about plant growth, animal visits, or weather effects.	Children can **make predictions** about the diversity of ants, about the contribution of ants to natural processes and their activities in nature

			Guide them to think about how robots might solve real-world problems.	**Ask** how the environment affects insect behaviour, linking this to sustainability.	
	RESEARCHING	The teacher only **supports** the process, and the ways chosen by the children. Focus on linking observations to both environmental and robotics outcomes.	**Introduce** children to **different types of robots** by showing pictures or videos and explaining their functions in simple terms. **Discuss** how robots help in various tasks like cleaning, teaching, or entertainment. This builds a basic understanding and sets the stage for more detailed exploration.	**Introduce** children to **different types of ecosystems** through pictures, videos, or simple explanations. **Discuss** how each element helps sustain the environment, like bees pollinating flowers or worms aerating the soil.	Using available materials, children are trying to **find answers** to all or some questions that have arisen in the previous steps. They can compare different species, identify and define their differences, etc.
CREATING	**COLLECTING DATA**	The teacher only **supports** the process and the ways chosen by the children	Provide children with opportunities to **observe and document** how a robot operates in a controlled setting. For example, they could watch a robot draw a line on paper and note down or verbally describe what they see—such as the robot's speed, the line's length, and the noise it makes.	Provide opportunities for children to **observe and document** environmental changes over time, such as the growth of a plant or the appearance of seasonal insects. They could note observations like plant height, number of leaves, or insect types.	Children can create posters, stories or drawings in groups about different ant species, summarising the information they have learned.

	INTERPRETING DATA	**Guide** the interpretation of data and facilitate discussions.	After collecting data, help children discuss what they observed. **Use questions** to guide their thinking, like "What happened when the robot moved faster?" This helps them start to make sense of the data by **connecting their observations to outcomes**.	After collecting data, help children discuss what they observed. **Relate findings to sustainable practices** like ecosystem protection. **Use questions** to guide their analysis, like "What happens to plants when we water them daily?" This encourages them to make connections between their actions and environmental outcomes.	After finding out the answers to the questions, children can try to **assume the role** of an ant, where everyone has to follow the "ant's path to the ant hill". **Outside** in the field, children can prepare a field with squares of the same size and obstacles made of natural materials—a tree, a pile of stones, a puddle (a bowl of water), a human foot, etc. This is an **unplugged activity** that helps children get to know and learn how to plan step sequences, understand the robot's movement around the field, while keeping in mind the capabilities and characteristics of the ant. **Discuss** "Can you think of how a robot's sensors, like cameras or touch sensors, work like the antennae of ants? How do both ants and robots figure out where to go and what to avoid?"

	EXPERIMENTS	**Support** children in planning and conducting experiments.	**Let children suggest** what they would like to see the robot do next. For example, they might wonder if the robot can draw a circle instead of a line. **Help them plan** how to make the robot perform this task by choosing the right commands or settings.	**Let children suggest** experiments related to the environment, such as testing different soil types for planting seeds or observing the effects of sunlight on plant growth. Assist them in planning how to carry out these experiments.	Children **become familiar** with educational robots (e.g., BeeBot), learning how they move and how they know where to go (sensors and coded steps). They **compare** robots and ants, noting similarities and differences. "We're going to use robots to act like ants avoiding obstacles. Imagine the robot is an ant looking for food. Place objects (like small blocks) on the robot's path to act as obstacles, just like an ant might find rocks, twigs or trash in its way".
	EXPERIMENTING	**Support** and encourage experimentation. Ensures tasks are clearly linked to the skills and strategies outlined in the IBL approach.	**Allow children to experiment** with the robot by trying out their predictions. For instance, they could program a path for the robot and see if it follows their planned route, adjusting their plans based on the outcome.	Allow children to carry out their **planned environmental experiments**, observing the effects of their variables and recording results.	Children **create** an ant cover for the BeeBot (or other) robot, making it an "Ant-Bot". Robotics task with BeeBot - analogue of the unplugged version performed in an outdoor environment. Indoors, carpet and/or natural materials used for obstacles, which children pick up during a walk (stones, cones, twigs, leaves, you can also make an improvised anthill from spruce/pine needles and glue).

REFLECT	**CONCLUDING**	**Guide and support** the reflective process.	Once the experiments are done, **guide** a discussion about the results. **Ask** questions like, "Did the robot do what you thought it would do?" and "What would you try differently next time?"	After experiments, **guide** discussions about the outcomes. **Encourage** questions like, "Did the plants grow as you expected?" and "What would you try differently next time?"	Children **try to summarise** both the ant-related and educational robot aspects. For example, children could create a commercial or video for parents or other children about what they learned – film each child telling/showing what they have learnt (small clips of children can be edited into larger videos). Encourage reflection on using robotics for environmental solutions, like pollution control.
	EVALUATING	**Guide and support** the evaluation process. Align evaluations with long-term goals.	Post-activity **encourages children to reflect** on what they learned. **Ask** questions like, "What did you find out about the robot when you changed its path?" or "How did you feel when the robot did/didn't do what you expected?" "Did everything go as they planned?"	Post-activity, have children **reflect** on their learning experiences. **Ask** questions like, "What did you learn about how plants grow?" or "How did you feel seeing the butterflies visit the flowers?" This helps them consolidate their learning and understand their impact on the environment.	Children **reflect** on the activities and the process of obtaining and compiling information, getting to know the robot, and imagining being an "Ant-Bot" (challenges, moments of satisfaction, etc.). Optional: Children can express if there are any unanswered questions or topics they became interested in during the lesson cycle, such as "How do bees live?" "How do bees move?" "What is the contribution of bees to nature?" "What is the significance of flowers in nature?" "How do other robots work?" etc.

Conclusion

The modules presented in the curriculum intertwine to unlock the potential of Inquiry-Based Learning (IBL) for the development of eco-friendly practices using educational robotics. The curriculum is founded on a strong theoretical background and presents plenty of opportunities to teach children about robotics. At the same time, teachers in Early Childhood Education (ECE) already face numerous challenges inside and outside of their respective organisations about educational robotics. As more and more technological advancements find their way into the education of young children, educators might feel overwhelmed by the risks they might bring to children and society. Therefore, this curriculum is meant to encourage all stakeholders in ECE to think about eco-friendly activities and the possibilities to use educational robotics as part of their educational designs. Not because new technology should be seen as a magical cure to the many challenges of the future, but because engaging with these technologies can lead to a better understanding of real opportunities and chances for environmental and social improvements.

As shown in Module 1, supporting children to engage and investigate phenomena in their everyday life leads to the creation of their own ideas and concepts, as well as the ability to reflect on their surroundings. Children from different ages greatly benefit from this approach (Baumgarten, 2023, Tumase 2023). Practical approaches to critical thinking and problem-solving strategies, such as drawing diagrams, asking questions or role play are outlined in Module 2.

Module 3 highlights the benefits of outdoor experiences, particularly nature-based play, for children. Besides some suggestions for ways of connecting educational robotics with outdoor activities for developing an environmental conscience, the module strives to articulate outdoor and indoor experiences for children's learning. This is a continuation of the processes presented for IBL where recording, discussion and reflecting are central to teaching.

Module 4 highlights the integration of robotics and coding into Early Childhood Education, focusing on developing critical skills like creativity, problem-solving, and environmental awareness. By engaging children in playful and hands-on activities such as creating nature mascots, building sea creatures from recycled materials, and digital recycling games, it provides an immersive, multidisciplinary learning experience. These activities help children explore programming, storytelling, and sustainability concepts in a fun, accessible manner, fostering collaboration and critical thinking from an early age.

Evaluation processes and documentation techniques explored in Module 5 can help teachers to develop specific instructional designs which can be adapted to the needs of individual children. To be effective, documentation must be done purposefully, with a focus on the learning process (rather than the outcome) with the clear goal to reflect on and change instructional designs, learning scenarios or learning environments. Practical methods for evaluation can include observations, written documentation, audio records, videos, artefacts of children's learning outcomes and much more.

The final module is Module 6 "Inquiry-Based Learning Approach: a Step-by-Step Guide", which is slightly different from the previous ones, as it is designed to give teachers a brief and structured overview of how to develop IBL approach for Early Childhood Education.

Considering the theory, methods, tools and practices outlined in this curriculum, teachers in ECE will be able to start the journey of implementing educational robotics for eco-friendly activities with young children. Obviously not all areas of this topic can be fully covered within this document and the examples might not reflect the reality stakeholders face in their given organisations. However, the GREENCODE curriculum is a powerful starting point for any teacher who accepts the challenge of introducing educational robotics and acknowledging the impact they can have for sustainable, eco-friendly practices.

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