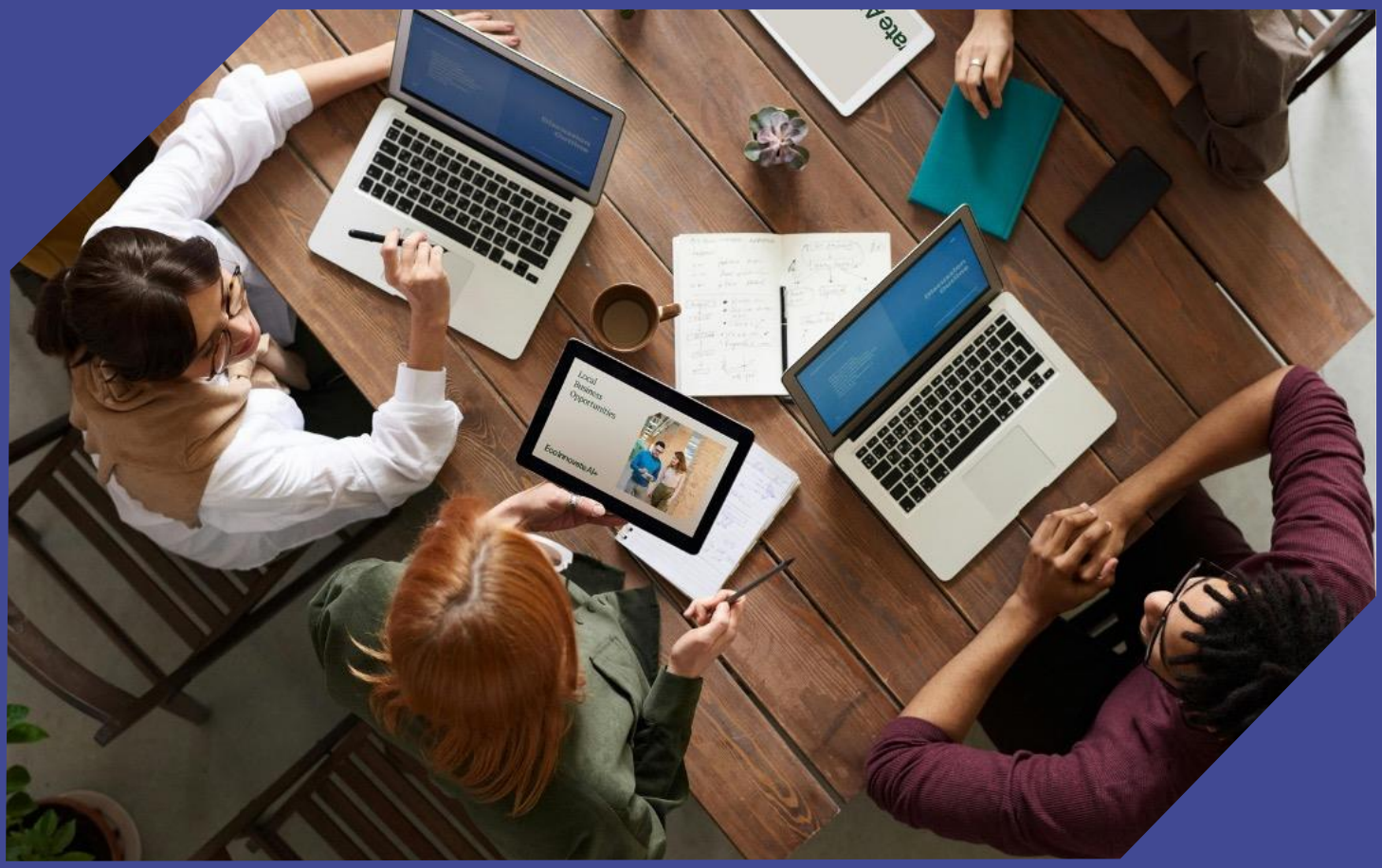
EcoInnovate AI+



ACT.2: Conceptual framework for EduBots

THE CRITICAL

2334 HAFELEKAR

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the National Agency. Neither the European Union nor National Agency can be held responsible for them.

Table of Content

1 Executive Summary

1.1 Purpose and scope of the report

This report presents the **Conceptual Framework for AI-Powered EduBots**, developed under **Action 2 (ACT.2)** of the *EcoInnovate AI+* project. The purpose of ACT.2 was to design and validate an integrated educational model for **AI-supported learning tools** that promote sustainability, digital literacy, and entrepreneurial competence in **Vocational Education and Training (VET)**.

The EduBots framework combines two innovation dimensions:

- The **Product-to-Service (P2S)** approach, which supports the transition from product-based to service-oriented and sustainable business models; and
- **AI-powered dialogue learning**, providing adaptive, reflective, and accessible digital environments.

EduBots are conceptualized as **interactive learning companions**, not as replacements for teachers. They guide learners through short, structured dialogues that connect sustainability and innovation concepts to their vocational field. This design helps make abstract principles—such as circular economy strategies and service-based value creation—tangible and relevant for everyday VET practice.

The conceptual framework was co-developed through:

- **Expert consultations** with VET educators, sustainability specialists, and business representatives in Austria and Lithuania; and
- **Targeted research** on P2S models, regional sustainability challenges, and competence needs in VET systems.

Together, these inputs ensured that EduBots address actual educational requirements and are both **pedagogically sound** and **technically feasible**.

The conceptual framework is structured around three key dimensions:

1. **Educational Soundness** – Strengthening green, digital, entrepreneurial, and systemic competences aligned with European VET and sustainability policy objectives.
2. **Technical Robustness** – Ensuring safe, adaptive, and multilingual AI dialogue systems that support consistent, structured learning outputs.
3. **Relevance for VET and Industry Needs** – Translating sustainability and innovation goals into practical learning experiences applicable across vocational sectors.

This framework provides the foundation for **ACT.3 (Pilot Testing and Refinement)**, where EduBots will be implemented and evaluated in real classroom environments in Austria and Lithuania.

1.2 Key findings on the EduBots conceptual framework

1. Progressive Integration of P2S Principles

The four EduBots form a stepwise learning pathway that introduces, deepens, applies, and communicates the principles of Product-to-Service innovation:

- *Change Explorer* – raises awareness of sustainability and service-oriented thinking;
- *Circularity Coach* – provides structured understanding through the 3P–10R framework;
- *Idea Builder* – guides learners in creating and structuring P2S-based solutions;
- *Value Shaper* – refines these ideas into concise, communicable value propositions.

This progression ensures cumulative competence development, moving from reflection to application.

2. Pedagogical Effectiveness: Active, Reflective, and Output-Oriented

EduBots promote **active engagement** rather than passive content consumption. Through guided dialogue, learners analyse, decide, and articulate reasoning connected to their professional practice. Each session produces **structured learning artefacts**—such as reflection summaries, lists of circular practices, idea outlines, or value propositions—that provide transparent evidence of learning and support formative assessment.

3. Technical and Educational Robustness

EduBots combine pedagogical structure with clear technical parameters: limited session length (8–10 learner inputs), one question per main turn, multilingual accessibility, and safe AI operation rules. These design elements ensure usability, inclusivity, and ethical reliability while preventing cognitive overload.

4. Relevance for Learners, Educators, and Institutions

The EduBots framework addresses VET needs at multiple levels:

- **Learners** gain hands-on experience in applying sustainability and innovation concepts to their vocational field.
- **Educators** receive modular, low-preparation tools that enhance reflection, discussion, and assessment.
- **Institutions** can integrate EduBots flexibly into existing curricula to strengthen green and digital competences without extensive redesign.

5. Responsiveness to Regional Contexts

EduBots were designed based on contextual research in Austria and Lithuania:

- In **Austria**, the focus lies on advanced skills such as lifecycle design and circular process management.
- In **Lithuania**, the emphasis is on applied green competences and entrepreneurial capacity for SMEs and VET learners.

  EduBots accommodate both needs through adaptable dialogue pathways, making them scalable across diverse European contexts.

6. Conditions for Successful Implementation

Experts identified three critical preconditions for EduBot deployment:

1. EduBots must stimulate **critical and systemic thinking**, not just factual recall.
2. They must be **easy to integrate** into existing lessons with minimal preparation.
3. Their content must maintain **practical relevance** and direct links to workplace or project contexts.

7. Contribution to the Twin Green and Digital Transitions

EduBots operationalize the goals of the **European Green Deal**, the **Digital Education Action Plan (2021–2027)**, and the **Council Recommendation on VET (2020)**. By combining sustainability and AI-supported learning, they help develop the core competences needed for Europe's future workforce—green, digital, and entrepreneurial skills—within authentic vocational learning settings.

1.3 Synthesis and Outlook

The The conceptual framework developed under ACT.2 demonstrates that **AI-driven educational tools** can effectively integrate sustainability and digital competences into VET when guided by sound pedagogy and structured dialogue design.

The EduBots framework shows that:

- Product-to-Service (P2S) thinking can be **introduced progressively and interactively**;
- Learners can **actively co-construct knowledge** and apply it to their professional context;
- Structured textual outputs make **learning visible, assessable, and transferable**;
- Technical simplicity and multilingual accessibility enable **scalability and inclusion**.

By uniting AI, sustainability, and vocational pedagogy, EduBots provide a **replicable model** for how digital learning companions can support Europe's **twin green and digital transitions**. The next phase, **ACT.3 (Pilot Testing)**, will validate and refine these concepts in practice, ensuring that EduBots are not only theoretically robust but also empirically proven, user-friendly, and pedagogically effective across diverse VET environments.

2 Introduction

This report situates the development of the EduBots conceptual framework within the broader objectives of the *EcoInnovate AI+* project, which seeks to strengthen vocational education and training (VET) by integrating sustainability principles and digital innovation. At its core, the project combines the **Product-to-Service (P2S) approach**, a model that promotes sustainable and service-oriented business practices, with **AI-powered learning tools** designed to make these concepts accessible and engaging. By doing so, EduBots are envisioned as practical instruments that help learners and educators navigate the challenges of the green and digital transitions. This chapter introduces the relevance of P2S for VET and outlines the role of EduBots in fostering the competencies required for future-oriented education.

2.1 P2S approach and relevance for VET

The **Product-to-Service (P2S) approach** reflects a significant shift in how businesses generate value, moving from selling physical products to delivering services that extend product use, create continuous customer engagement, and minimize resource waste. This transition is closely linked to the principles of the **circular economy**, as it encourages companies to rethink design, production, and consumption patterns in ways that prioritize sustainability and long-term value creation. It also directly supports the objectives of the **European Green Deal**, which promotes climate neutrality and resource efficiency across all sectors.

For the **Vocational Education and Training (VET)** sector, integrating P2S concepts is particularly relevant because it directly addresses the evolving needs of the labour market. Across Europe, employers increasingly seek graduates who understand not only technical skills but also **systemic thinking**, **sustainability principles**, and **service-oriented innovation**. According to CEDEFOP (2023), more than two-thirds of European VET institutions identify green and digital competences as their most urgent development areas. By exposing VET learners to P2S models, training institutions can better equip them to respond to this growing demand and to contribute actively to the **twin green and digital transitions**.

P2S is also highly compatible with **entrepreneurial education**, as it requires learners to consider customer needs, service design, and business innovation simultaneously. For VET learners, this means developing the ability to combine practical skills with strategic insight, enabling them to design solutions that are both economically viable and environmentally responsible. This approach aligns with the **European Skills Agenda (2020)** and the **Osnabrück Declaration on VET (2020)**, which emphasize sustainability, innovation, and entrepreneurship as essential competences for the future workforce.

From an institutional perspective, embedding P2S into VET curricula helps **modernize teaching approaches**. It supports educators in connecting sustainability topics with real-world applications and provides a structured way to foster **interdisciplinary competences** — from digital literacy and green skills to collaboration and adaptability. In doing so, P2S strengthens the capacity of VET systems to prepare learners not only for immediate employment but also for broader societal goals such as **climate neutrality, inclusion, and responsible innovation**.

Within the **EcoInnovate AI+ partnership**, this approach also reflects the institutional ambitions of both partners. **UAB The Critical** expands its applied sustainability and service design methodologies in Lithuanian VET settings, while **Hafelekar Consulting** advances its expertise in AI-supported VET innovation in Austria. Together, these complementary perspectives ensure that P2S principles are implemented in ways that respond to diverse regional needs and that promote shared European values of **sustainability, equity, and collaboration**.

2.2 Role of EduBots in digital and green skills development

As VET systems adapt to the demands of the **green and digital transitions**, the need for innovative teaching and learning tools becomes increasingly urgent. Traditional classroom methods often struggle to capture the complexity of sustainability challenges or to provide learners with opportunities for hands-on experimentation. In this context, **AI-powered EduBots** emerge as a timely and practical solution, offering interactive, adaptive, and accessible support to both learners and educators. They operationalize the goals of the **Digital Education Action Plan (2021–2027)** and the **European Green Deal** by linking technology-enabled learning with sustainable thinking in everyday training contexts.

Supporting Digital Skills

EduBots are, first and foremost, **digital learning companions** that help learners become familiar with advanced technologies in a guided and educationally meaningful way. By engaging in interactive dialogues, learners practice how to search, analyze, and apply information in digital environments. This strengthens **digital literacy**, critical thinking, and confidence in using AI-based tools—competences that are essential across all sectors of the modern labour market. Moreover, EduBots introduce learners to **data-driven decision-making** and **digital communication**, preparing them for workplaces where technology is deeply integrated into daily tasks. They also help learners understand the **ethical use of AI**, ensuring responsible digital behaviour and awareness of privacy, bias, and transparency in automated systems.

Strengthening Green Competences

EduBots are designed to facilitate the development of **green skills** by embedding sustainability principles into interactive learning experiences. Through simulated real-world challenges—such as resource efficiency, circular design, or service-based innovation—learners can test and evaluate decisions in a low-risk environment. Guided reflection helps them explore the environmental, social, and economic consequences of different business choices. This approach deepens understanding of sustainability while fostering the **systemic and critical thinking** required to balance ecological responsibility with economic viability. In doing so, EduBots support learners in applying circular economy concepts and Product-to-Service (P2S) thinking in their vocational fields.

Enabling Adaptive and Personalized Learning

A key advantage of EduBots lies in their ability to provide **personalized and inclusive learning pathways**. Unlike static materials, EduBots adapt to individual learner input—tailoring explanations, examples, and follow-up questions to each participant's pace and level of understanding. For VET learners, who often represent diverse educational and linguistic backgrounds, this adaptability ensures equitable access to learning and supports inclusion, one of the **core EU values**. For educators, EduBots reduce the burden of differentiation in the classroom by offering targeted guidance and automated formative feedback that complements traditional instruction.

Bridging Theory and Practice

EduBots help make abstract sustainability and innovation concepts tangible by linking **theory with applied practice**. Learners can engage in scenario-based exercises, role plays, and interactive simulations that mirror workplace situations, such as designing service-oriented business strategies or assessing the environmental impacts of operational decisions. This direct connection between classroom learning and real-world practice strengthens employability and supports the **European Skills Agenda's** objective of developing work-relevant competences for a sustainable economy.

Supporting Educators and Institutions

The benefits of EduBots extend beyond individual learners. For educators, EduBots function as **co-teaching assistants**, supporting classroom dialogue, assessment, and reflection activities. They provide ready-to-use prompts and formative tools that make lessons more engaging and efficient. For institutions, EduBots contribute to **curriculum modernization** by embedding green and digital competences into existing programs. This supports alignment with EU and national policy frameworks on sustainability, innovation, and digitalization, while enhancing institutional visibility and attractiveness to students.

Contribution to the Twin Transition

Ultimately, EduBots act as catalysts for the **twin green and digital transition** in VET. By merging AI-driven interactivity with sustainability-focused learning content, they help learners and educators advance both **digital competences** and **green skills** in an integrated way. This dual focus directly contributes to Europe's long-term vision of climate neutrality and future-ready education systems. Within **EcoInnovate AI+**, EduBots embody how artificial intelligence can be used not only to automate processes but also to enhance human learning, creativity, and responsibility in the context of sustainable development.

3 Methodology

The methodology underpinning the development of the EduBots conceptual framework combined **expert consultations** with **targeted research** on Product-to-Service (P2S) practices and VET-specific challenges. This mixed approach ensured that the concept is both **pedagogically grounded** and **industry-relevant**, responding to the needs of learners, educators, and business stakeholders. The consultations provided **qualitative insights** into practical expectations, barriers, and opportunities, while research activities structured the content base for EduBots around **sustainability** and **service innovation principles**.

3.1 Expert consultations (educators, sustainability professionals)

To refine the EduBots concept, a series of **expert consultations** were carried out with VET educators, business representatives, and sustainability specialists in **Austria** and **Lithuania** between **March and May 2025**. These discussions offered diverse perspectives on the **educational, technical, and practical dimensions** of the EduBots and informed the subsequent design and content development phases.

Austrian experts

- **Circular economy specialists** emphasized the importance of anchoring EduBots in systemic sustainability frameworks, particularly the **10R hierarchy** (Refuse, Rethink, Reduce, Reuse, etc.). They underlined that EduBots should not merely transmit information but actively **stimulate critical reflection**, for example, by prompting learners to question product necessity, explore design for reuse, and evaluate sustainability trade-offs. Experts also highlighted the potential for **scenario-based learning**, where learners make design decisions and immediately observe their environmental and economic consequences.
- **Think tank and NGO representatives** underlined the broader applicability of EduBots beyond formal VET environments. They identified potential uses in **awareness campaigns, professional upskilling, and policy dialogues**, suggesting that EduBots could support lifelong learning on sustainability topics. They recommended the integration of **visualizations, interactive simulations, and real-world success stories** to make circular economy strategies tangible and engaging.
- **VET pedagogy experts** stressed that teachers require **ready-to-use lesson packages**—including scripts, slides, and classroom activities—to integrate EduBots effectively. They proposed a **modular design**, allowing EduBots to provide pre-structured teaching scenarios that educators can easily adapt to local curricula and learning contexts. This would ensure **pedagogical consistency** and reduce preparation workload for teachers.

Lithuanian experts

- **VET teachers** expressed a mix of attitudes toward sustainability and AI. Some remained **skeptical**, viewing these topics as trends with limited relevance for traditional crafts such as welding. Others, particularly in **construction and technical fields**, recognized clear potential and already apply circular practices, such as material reuse, within training. They saw EduBots as valuable **lesson support tools**, provided that the modules remain **short, practice-oriented**, and easy to integrate into daily teaching.

- **Floristry educators** showed limited engagement with systemic sustainability but acknowledged EduBots' potential to make lessons more **interactive, playful, and reflective**, especially when the content encourages **critical and creative thinking**.

- **Business representatives**, especially from sectors such as **landscaping and environmental services**, strongly supported the EduBots concept. They viewed the tools as effective in **connecting fragmented knowledge**, fostering **holistic and entrepreneurial thinking**, and preparing learners to communicate sustainability principles to clients. They emphasized that EduBots could **bridge the gap between classroom theory and real-world practice**, particularly in professions where ecological innovation is becoming a competitive advantage.

Synthesis

The consultations revealed **three cross-cutting priorities** for EduBot design and implementation:

1. **Critical thinking and systemic reflection** – EduBots must go beyond factual learning to encourage learners to question, analyze, and apply sustainability concepts in their professional contexts.

2. **Pedagogical integration and ease of use** – EduBots should include structured lesson materials, adaptable content, and guidance for teachers to ensure **low-preparation integration** into existing curricula.

3. **Practical relevance and adaptability** – EduBots must link classroom learning with real-world business practices and be adaptable to various **VET sectors, skill levels, and national contexts**.

These insights were directly integrated into the **EduBots conceptual framework**, ensuring that the tools address real educational needs, align with **industry expectations**, and remain flexible enough to support **diverse learners and educators** across different European VET systems. The participatory approach also reinforces **EU principles of inclusion, collaboration, and innovation**, core elements of the **EcoInnovate AI+ project's methodology**.

3.2 Research on P2S practices and VET-specific challenges

The **research phase** complemented the expert consultations by examining **regional sustainability challenges** and their implications for **Vocational Education and Training (VET)** in **Austria** and **Lithuania**. The aim was to understand how the **Product-to-Service (P2S) approach** can address pressing environmental and economic issues while identifying the specific **skills gaps** that EduBots should target. This analytical dimension ensures that EduBots are not only pedagogically sound but also **context-sensitive**, responding directly to the regional realities and labour market needs of both partner countries.

Austria

Austria demonstrates relatively strong progress in implementing **circular economy policies**, with a **Circular Material Use Rate (CMUR)** of **11.5%**, close to the EU average. However, **Domestic Material Consumption (DMC)** remains high at approximately **17 tonnes per person per year**, indicating continued dependence on material-intensive production. Research revealed **persistent urban–rural disparities**: while large cities lead in renewable energy deployment, sustainable transport, and waste management innovation, rural regions lag behind in infrastructure and institutional capacity.

For the **VET sector**, this imbalance signals the need to prepare learners not only for **advanced urban sustainability projects** but also for adaptation in **resource-constrained rural environments**. Skills shortages were particularly evident in:

- **Reverse logistics**,
- **Product lifecycle design**, and
- **Circular process management**.

These areas require practical, scenario-based training tools—precisely where **EduBots** can provide accessible learning experiences. By embedding P2S principles into interactive simulations, EduBots can help Austrian VET learners acquire the **specialized competences** necessary to manage sustainable production cycles and implement circular solutions across different industrial contexts.

Lithuania

Lithuania faces even more pressing challenges. With a **DMC of 20 tonnes per person per year** and a **CMUR of only 4.1%**, it ranks among the lowest in the EU for circularity. Despite national strategies targeting a **transition to a circular economy by 2035**, the economy remains heavily reliant on **linear "take–make–dispose" models**. Pronounced regional inequalities further complicate progress—some municipalities show innovation capacity, while others lack infrastructure and human resources.

The research highlighted a **critical shortage of sustainability competences** among **small and medium-sized enterprises (SMEs)**, limiting their capacity to adopt circular and service-oriented business practices. For VET, this creates an urgent need to integrate **P2S and circular economy competences** into training pathways, equipping learners with hands-on skills in:

- **Resource efficiency**,
- **Waste reduction**, and
- **Service innovation**.

EduBots can support this transition by making sustainability concepts more **tangible**, offering interactive guidance and low-barrier access to learning in digital environments—especially relevant for smaller VET institutions with limited capacity for in-person innovation training.

Comparative insights

A comparative analysis reveals that, while Austria is **more advanced in policy frameworks**, both countries share **skills gaps** as a primary obstacle to progress. The differences are primarily in the **depth and type of competence required**:

- **Austria** requires specialized, technical competences—such as lifecycle design and reverse logistics—suited to advanced manufacturing and service innovation contexts.
- **Lithuania**, by contrast, requires broad systemic awareness, applied green skills, and entrepreneurial capacities that enable learners and SMEs to initiate the circular transition at a foundational level.

These contrasting needs reinforce the **relevance of EduBots** as a **scalable, flexible, and accessible learning tool** that bridges educational and economic disparities by:

- Introducing learners to **P2S principles** through engaging, context-based dialogues.
- Providing **adaptive simulations** of service-oriented business models applicable across multiple vocational fields.
- Supporting **digital competence development** alongside sustainability awareness for both VET learners and SME employees.

The research confirms that EduBots serve as a **pedagogical response** to regional sustainability challenges, translating **policy objectives**—including those set out in the **European Green Deal**, the **Circular Economy Action Plan (2020)**, and the **European Skills Agenda (2020)**—into **practical skills development**. By aligning P2S practices with the specific socio-economic contexts of Austria and Lithuania, the EduBots framework ensures **local relevance**, **scalability**, and measurable **European-level impact** in advancing the twin green and digital transitions.

4 Conceptual Framework

The **conceptual framework** developed under **ACT.2** serves as the foundation for the EduBots and defines how they will function as effective, engaging, and sustainable learning tools in the **Vocational Education and Training (VET)** context. It integrates insights from **expert consultations**, **regional sustainability research**, and **pedagogical design principles**, forming a model that is **technically feasible**, **educationally robust**, and **aligned with real-world needs**.

This framework ensures that EduBots go beyond the role of a digital resource. They act as interactive learning partners that foster reflection, problem-solving, and applied understanding in the context of the **green and digital transitions**. The approach reflects the broader objectives of the **EcoInnovate AI+** project and is consistent with the principles of the **European Green Deal**, the **Digital Education Action Plan (2021–2027)**, and the **Osnabrück Declaration on VET (2020)**, which emphasize the need for innovative, inclusive, and competence-oriented education systems.

Guiding Dimensions of the Framework

The framework is built upon **three interrelated dimensions**:

1. **Structure and Core Components** – defining how EduBots are organized, what elements they include (knowledge base, dialogue design, interaction flows), and how these components work together to deliver coherent, progressive, and engaging learning experiences.

2. **Integration of P2S Principles** – embedding researched **circular economy** and **service-based innovation** models into the EduBots' dialogue logic, ensuring that learners engage not only with theoretical ideas but with **practical, scenario-driven challenges** relevant to their vocational contexts. This allows the learning process to reflect authentic problem-solving and decision-making situations.

3. **Educational and Technical Robustness** – ensuring that EduBots are not only **technologically reliable** but also **pedagogically effective**. They provide educators with **ready-to-use, modular lesson content** and enable learners to develop **green**, **digital**, and **entrepreneurial competences**. This dual focus on usability and learning outcomes supports sustainable integration into everyday VET practice.

Interactive and Learner-Centered Design

Unlike traditional e-learning tools, EduBots are designed to act as **interactive co-learners**. They guide users through problem-solving tasks, pose reflective questions, and provide **adaptive feedback** tailored to learner input. This dialogical design mirrors real-life coaching processes, fostering active engagement and promoting **self-directed, inquiry-based learning**. Such features make EduBots particularly suitable for VET, where **hands-on and experiential learning** is central to competence development and employability.

Stakeholder Relevance and Benefits

The framework also acknowledges the **diverse needs of stakeholders** across the VET ecosystem:

- **For learners**, EduBots offer an **engaging and supportive entry point** into complex topics such as sustainability, circular economy, and Product-to-Service (P2S) innovation. Their adaptive design ensures accessibility for learners with varying skill levels and learning preferences.
- **For educators**, EduBots serve as **digital teaching assistants**, providing modular learning sequences, interactive prompts, and automated feedback. This reduces preparation time and allows teachers to focus on facilitation, mentoring, and assessment.
- **For institutions and businesses**, EduBots establish practical **pathways to integrate circular economy and service innovation** into vocational curricula and workforce development programs. They support curriculum modernization and enhance institutional capacity to respond to emerging sustainability and digitalization priorities.

Scalability and Future Development

The conceptual framework establishes the **foundation for scalability and continuous refinement**. Its modular structure enables the expansion of EduBots to new vocational fields and national contexts. The upcoming phases of the **EcoInnovate AI+ project (ACT.3)** will pilot and test these components with VET institutions, ensuring that the tools are **inclusive**, **transferable**, and aligned with both **local realities** and **European-level objectives**.

The following subsections provide detailed insight into the framework's three key dimensions:

- **Section 4.1:** Structure and Core Components
- **Section 4.2:** Integration of P2S Principles
- **Section 4.3:** Educational and Technical Robustness

Together, these elements define a **comprehensive and adaptable model** that bridges digital innovation with sustainability-oriented learning and equips VET systems to lead Europe's **twin green and digital transitions**.

4.1 Structure and core components

The **conceptual architecture of EduBots** is designed as a **progressive learning system**, where each EduBot has a distinct pedagogical role but together they form a **coherent educational pathway** for VET learners. This structure enables learners to move step by step from **awareness to application** – first exploring change, then consolidating knowledge, developing ideas, and finally transferring learning into vocational or entrepreneurial contexts.

This progression reflects competence-oriented learning principles consistent with the **Osnabrück Declaration on VET (2020)** and the **European Skills Agenda (2020)**, both of which emphasize experiential and digitally supported learning for the twin green and digital transitions.

The design of the four EduBots follows several guiding principles:

- **Stepwise scaffolding –** Each EduBot builds on insights from the previous stage, ensuring continuity and gradual deepening of understanding.
- **Dialogical interaction –** EduBots use a conversational, one-question-at-a-time structure to foster engagement and reflection, supporting active rather than passive learning.
- **Contextual adaptation –** Learners are prompted to relate sustainability and innovation themes directly to their professional or vocational fields, increasing practical relevance and authenticity.
- **Structured yet flexible outcomes –** Each EduBot interaction results in a **traceable learning output** – for example, notes, key reflections, or preliminary ideas – that can support further learning or class discussion. The exact format of these outcomes will be refined during pilot testing to ensure they meet user needs and technical feasibility.
- **Inclusivity and accessibility –** Multilingual functionality (English, German, Lithuanian) and adaptable examples allow learners from diverse backgrounds and skill levels to participate effectively. The design follows principles of universal accessibility and low digital-entry requirements.

Together, the four EduBots create a **coherent and progressive learning pathway** that mirrors an innovation process from awareness to application and reflection. Each EduBot has a specific learning function while remaining connected to the overall educational framework.

1. **EduBot 1 – Change Explorer** introduces sustainability and Product-to-Service (P2S) thinking within various VET sectors, sparking curiosity and self-reflection on how professional practices can evolve toward circular and service-oriented models.
2. **EduBot 2 – Circularity Coach** deepens understanding through a structured exploration of sustainability principles such as the 3P–10R framework. It helps learners analyze circular strategies in their own vocational field and recognize interconnections between environmental, social, and economic dimensions.

3. **EduBot 3 – Idea Builder** encourages learners to apply their understanding in creative ways. It supports the generation and initial structuring of ideas that link sustainability thinking with practical vocational challenges. The focus is on stimulating innovation, collaboration, and exploratory reasoning rather than producing finalized business or service concepts.

4. **EduBot 4 – Value Shaper** guides learners in refining and articulating their ideas into clear, communicable propositions that express the added value of sustainable and service-oriented approaches in their profession or training field.

Each EduBot is designed to be both **independent**—usable as a standalone learning unit—and **interconnected**, contributing to a gradual progression in learning depth and application. This dual structure allows educators to integrate EduBots flexibly into diverse instructional settings, from individual study to group-based learning.

The sequential progression from reflection to idea development and articulation supports a **competence-oriented learning journey** adaptable to various vocational sectors and learner profiles. The detailed design and interaction logic of each EduBot will be refined and validated during the **pilot testing phase (ACT.3)** to ensure both **pedagogical effectiveness** and **technical feasibility**.

The following subchapters (**4.1.1–4.1.4**) describe each EduBot in more detail, outlining its pedagogical role, interaction design, and intended contribution to the overall EduBots learning pathway.

4.1.1 EduBot 1 – Change Explorer

Role and Purpose

Change Explorer is the **starting point of the EduBots learning journey**. Its main role is to **spark curiosity and reflection** among VET learners by linking sustainability issues with their own professional field. Instead of overwhelming users with complex theories, it provides an **accessible entry point** that shows how sustainability challenges are directly relevant to vocational training and future workplaces. By the end of the session, learners develop a **basic understanding of the Product-to-Service (P2S) concept** and identify first ideas for potential action in their context.

This EduBot supports the broader objectives of the **European Green Deal** and the **Osnabrück Declaration on VET (2020)** by encouraging early awareness and motivation for green and digital competences through interactive learning.

Pedagogical Design

Change Explorer is built as a **dialogical reflection tool** that guides learners step by step through short, interactive prompts. Each exchange encourages active participation, linking abstract ideas with familiar, everyday vocational settings. The interaction follows a structured yet flexible progression:

1. Identifying the learner's **profession or training field**.
2. Reflecting on visible **sustainability challenges** (e.g. waste, energy use, single-use materials).
3. Introducing the **P2S model** in simple, profession-relevant language.
4. Exploring **concrete examples** of P2S practices in the learner's field.
5. Considering how such approaches could be **applied locally** in training or work environments.
6. Concluding with a short **personal reflection summary** that can be revisited later.

This structure follows the principle of **scaffolding**: starting from what learners already know, introducing new concepts gradually, and encouraging them to relate sustainability ideas to their professional identity and practice.

Interaction Structure

- **Multilingual accessibility:** Available in English, German, and Lithuanian on the EcoInnovate AI+ platform, ensuring inclusive participation across partner regions.
- **Short and focused sessions:** Limited to 6–8 steps with one question per turn, maintaining attention and cognitive engagement without fatigue.
- **Reflective rather than evaluative:** Prompts stimulate critical thinking and personal connections rather than testing factual knowledge.
- **Concise reflection output:** Each session concludes with a **summary of the learner's reflections**, including their profession, observed challenges, basic understanding of P2S, and one small idea for action. The format remains adaptable and will be fine-tuned during pilot testing.

Added Value for Learners and Educators

For learners, Change Explorer offers an **easy, motivating, and low-pressure entry point** to sustainability and service thinking. It helps them recognize that sustainability is not an abstract concept but directly connected to their everyday work and career prospects. For educators, the reflection summaries serve as **learning artefacts** that can be collected, shared, or discussed in class, supporting collaborative reflection without adding workload or assessment pressure.

Position in the EduBot Sequence

As the **first EduBot**, Change Explorer lays the foundation for the full learning pathway. It ensures that all learners—regardless of prior knowledge—begin the process with a **personalized understanding of sustainability challenges** and a first encounter with **P2S logic**.

The insights developed here form the **starting point for EduBot 2 (Circularity Coach)**, where learners deepen their knowledge using the structured **3P–10R framework** and connect individual reflections with systemic sustainability strategies.

4.1.2 EduBot 2 – Circularity Coach

Role and Purpose

The **Circularity Coach** is the **knowledge-building module** in the EcoInnovate AI+ EduBots sequence. After learners have explored sustainability challenges with the **Change Explorer**, this EduBot introduces the **core logic of the circular economy** through the **3P–10R framework** (Refuse → Recover). Its purpose is to help learners understand how circular thinking applies to their own profession or training field by guiding them through concrete, clearly structured examples.

The Circularity Coach focuses on **practical awareness and terminology** rather than idea generation. It functions as a **conceptual bridge**: transforming the learner's initial reflections from EduBot 1 into structured, profession-specific knowledge that later supports more creative exploration in the **Idea Builder**.

Pedagogical Design

The bot uses a **stepwise interactive model** that combines short explanations, profession-specific illustrations, and comprehension checks. Learners are guided through three main principles of circularity:

1. **Intelligent Production & Use** – Refuse, Rethink, Reduce.
2. **Extend Product Lifespan** – Reuse, Repair, Refurbish, Remanufacture, Repurpose.
3. **Recycle & Recover** – Recycle, Recover.

Each principle is explained in simple language (CEFR B1 level), followed by short examples drawn from relevant vocational domains. After each principle, the EduBot checks understanding and requires the learner to confirm continuation by typing **"1"**. This controlled pacing keeps the conversation linear and ensures that users engage actively with each stage before moving forward.

The pedagogical approach reflects **scaffolding** and **micro-learning** principles: learners receive manageable portions of content, each directly linked to a clear example and a reflection prompt.

Interaction Structure

- **Multilingual availability:** English, German, and Lithuanian versions are accessible on the EcoInnovate AI+ website.
- **Strict sequencing:** The EduBot follows the full 3P–10R order without skipping or previewing later content.
- **Pagination and gating:** Learners progress by replying **"1"** at defined points. This prevents cognitive overload and preserves attention.
- **Session length:** Normally 8 user inputs (up to 10 if clarification is requested).
- **Final reflection:** After completing all ten R-strategies, learners review a concise recap and identify their **Top 3** examples that they found most relevant or interesting. Each selected example is then expanded with a short explanation of its **environmental, social, and economic implications**, as specified in the system design.

No additional recommendations or task lists are produced; the interaction ends with a neutral closing message acknowledging completion of the module.

Core Components of the Session Output

The Circularity Coach produces a short **recap summary** presented on-screen at the end of the dialogue. This recap includes:

- An overview of the three Principles and the corresponding R-strategies covered.
- The list of examples shown during the conversation, grouped by principle.
- The learner's chosen **Top 3** examples, each accompanied by a concise description of their potential **environmental, social, and economic aspects**.

This summary remains part of the conversation thread; it is not stored externally or exported.

Added Value for Learners and Educators

For learners, the Circularity Coach clarifies **how circular practices translate into everyday vocational work**. It demonstrates how reducing waste, extending product lifespans, and organizing recovery processes relate to concrete professional tasks.

For educators, it serves as a **conceptual and illustrative resource** that supports classroom discussion or preparatory learning without requiring additional materials. It can be used as a stand-alone digital learning activity or integrated into broader sustainability training modules.

Position in the EduBot Sequence

The Circularity Coach follows the **Change Explorer** by shifting the focus from personal reflection to **structured understanding**. It equips learners with a **shared vocabulary and conceptual framework**—the 3P–10R model—that underpins the subsequent **Idea Builder** stage. This ensures continuity across the EduBots pathway while maintaining pedagogical realism and technical feasibility at the current stage of development.

4.1.3 EduBot 3 – Idea Builder

Role and Purpose

The **Idea Builder** is the **entrepreneurial design EduBot** within the EcoInnovate AI+ sequence. Its role is to help learners turn an initial sustainability idea into a **structured Product-to-Service (P2S) concept** using a short, guided conversation. While the previous EduBots—**Change Explorer** and **Circularity Coach**—focus on awareness and structured knowledge, the Idea Builder introduces a **creative and problem-solving dimension**, encouraging learners to apply what they have learned to real vocational contexts.

The EduBot supports learners in defining a specific problem, selecting an appropriate P2S pathway, and formulating the essential components of a service-oriented idea. It does not evaluate environmental or social impacts but focuses entirely on the **logic and feasibility of the idea itself**.

Pedagogical Design

The Idea Builder is designed as a **step-by-step co-creation tool** that guides learners through reflection and clarification rather than instruction. It follows a six-step conversational structure in which each turn prompts the learner to contribute information that becomes part of the final idea summary.

Learning flow:

1. **Orientation and level setting** – Learners state their profession and familiarity with P2S (Starter, Intermediate, or Advanced). The EduBot adapts the depth of dialogue accordingly.

2. **Problem definition** – Learners describe a concrete problem related to product use, waste, or inefficiency in their vocational sector.

3. **P2S angle selection** – The EduBot presents short menus of possible service models such as *Access-as-a-Service*, *Uptime-as-a-Service*, *Usage-based*, *Upgrade/Swap*, or *Data-enabled services*.

4. **Service basics** – The conversation focuses on identifying the intended users, the core offer, and simple operational details such as access frequency, maintenance, and handling of faults or upgrades.

5. **Inventory and resource gaps** – Learners list what they already have (materials, skills, partners) and what would still be needed to test their idea.

6. **Risks and first steps** – Learners outline the main risk and one mitigation measure, followed by the first small steps for testing their idea.

This clear and repeatable structure promotes **entrepreneurial reasoning**, **vocabulary use**, and **structured thinking** within a low-pressure environment. The session typically consists of six to eight short user turns, each limited to one open-ended question.

Interaction Structure

- **Languages:** English, German, and Lithuanian versions are available via the EcoInnovate AI+ platform.

- **Adaptivity:** The EduBot automatically adjusts to the learner's level (Starter, Intermediate, Advanced), providing simplified or extended prompts as appropriate.

- **One-question-per-turn design:** Learners respond to concise, motivating prompts without multitasking or long reading loads.

- **Pagination:** For longer content sections, the EduBot uses "Reply '1' to continue," maintaining attention and ensuring comprehension.

- **Summary format:** At the end of the dialogue, the EduBot automatically produces a **copy-ready summary block**, which compiles only the content that the learner has personally provided. The EduBot does **not add, infer, or invent** additional points.

The session ends once the summary is generated. No further discussion or impact analysis takes place within this module.

Core Components of the Session Output

The **Idea Builder Summary** is a standardized text block that can be copied by the learner for later use in **EduBot 4 – Value Shaper**. It contains the essential descriptive elements of the idea, structured according to the learner's inputs.

The summary includes:

1. **Problem in the sector** – A concise statement of the identified issue and who is affected.
2. **Chosen P2S angle** – The selected service model(s) relevant to the learner's vocational field.
3. **Service basics** – Description of the service offer, access, and how issues such as faults or upgrades are handled.
4. **Available resources** – Materials, tools, knowledge, and people the learner already has.
5. **Needed resources** – Gaps such as partners, permissions, or funding.
6. **Risk and mitigation** – One main risk and a practical countermeasure.
7. **First five steps** – A short list of actions the learner would take to test the idea on a small scale.
8. **(Optional)** Differentiation or assumptions – Only if explicitly discussed during the dialogue

The format is designed to be **self-contained** and **evidence-based**, reflecting only user-provided input. It must be saved manually by the learner to be reused in the next EduBot session.

Added Value for Learners and Educators

For learners, the Idea Builder provides a **guided framework for creative reasoning**. It helps them articulate a sustainability-oriented service idea using clear logic and minimal jargon, fostering confidence in discussing innovation concepts.

For educators, the EduBot can be integrated into **project-based or entrepreneurship-oriented VET modules**. The generated summary provides a transparent view of learner thinking and progression without requiring complex assessment tools. The format can also support peer review or small-group comparison activities.

Position in the EduBot Sequence

The Idea Builder builds on the foundations laid by **Change Explorer** (awareness) and **Circularity Coach** (structured understanding). It marks the transition from knowledge acquisition to **applied concept development**, guiding learners toward defining actionable P2S ideas in their vocational field.

Its summary output forms the **mandatory input for EduBot 4 – Value Shaper**, where the idea is refined into a coherent and communicable value proposition. This step ensures continuity and cumulative learning across the EduBot sequence.

4.1.4 EduBot 4 – Value Shaper

Role and Purpose

The **Value Shaper** is the **final EduBot** in the EcoInnovate AI+ sequence and serves as a **refinement and communication tool**. Its main purpose is to help learners consolidate their Product-to-Service (P2S) ideas into a **clear, concise, and persuasive value proposition**. It enables learners to articulate *who* their service is for, *what* problems it solves, *which* benefits it provides, and *why* it has value in both economic and sustainability terms.

At this stage, the focus shifts from concept development to **value communication and positioning**. Learners are guided to express their P2S idea from the perspective of real users and potential supporters. This step ensures that their learning journey concludes with a **structured, communicable output**, relevant to both educational and professional contexts.

Pedagogical Design

The Value Shaper follows a **guided coaching model** structured around the logic of **value proposition design**. The conversation is concise, using short mini-forms and targeted reflection prompts that lead the learner through successive stages of reasoning.

The pedagogical flow is strictly aligned with the system prompt and includes:

1. **Idea intake** – Learners paste the *Idea Builder summary* or provide a short 3-line description of their P2S concept.
2. **Persona definition** – They identify *who* the service is for, including context of use and adoption rationale.
3. **Pain identification** – Learners list the main frustrations or challenges that their persona faces with current solutions.
4. **Value clarification** – They specify the intended gains and benefits their service provides, such as convenience, reliability, cost savings, or sustainability.

5. **Adaptation of idea to persona** – The P2S model is adjusted to fit the selected user profile, creating a user-centered version of the concept.
6. **Impact mapping** – Learners briefly describe the *social, environmental, and economic* implications for both creator and client.
7. **Pitch creation** – Two short pitches are developed:
    - a **client-facing version**, emphasizing practical benefits and usability, and
    - an **investor-facing version**, focusing on market logic, creator value, and sustainability potential.

This design supports **critical reflection, synthesis, and applied communication skills**. The EduBot's flow ensures that learners can complete the exercise in **three to five short inputs**, avoiding overload while still covering each value dimension.

Interaction Structure

- **Multilingual delivery:** Available in English, German, and Lithuanian via the EcoInnovate AI+ platform.
- **Concise pacing:** Typically four conversational turns (up to five if clarifications are needed).
- **Mini-form input:** Learners fill short fields per step (e.g., persona, pains, gains) instead of long text entries.
- **Contrast examples:** Examples from unrelated fields are used to demonstrate structure and avoid imitation.
- **Sequential gating:** The EduBot uses "Reply '1' to continue" when sections are lengthy, keeping the interaction linear and manageable.
- **No repetition:** Once information is provided, the EduBot reuses it without re-asking questions.
- **Summary generation:** When the learner confirms completion ("finish," "done," or "summary"), the EduBot compiles all entries into the **Value Shaper Summary**, then closes the session without further questions.

Core Components of the Session Output

The final **Value Shaper Summary** is a structured, text-based synthesis created entirely from the learner's own inputs. It functions as a **pitch-ready artefact** for class presentation or follow-up project work.

The summary includes:

- **For Whom (persona):** Description of the target user or client, their context, and early-adopter rationale.
- **Pains:** Two to three key challenges or inefficiencies in the user's current experience.
- **Adapted Idea:** A short, refined version of the P2S concept tailored to the persona.
- **Value/Gains:** The main benefits or advantages for the user (e.g., reliability, predictability, resource efficiency).
- **One-line Value Proposition:** A concise statement following the model: *"For [persona] who [pain], our [P2S service] delivers [gains] by [how it works]."*
- **Impact Map:**
    - *Social impact* (brief note).
    - *Environmental impact* (brief note).
    - *Economic impact — Creator:* short statement or metric about income predictability or asset use.
    - *Economic impact — Client:* short statement about reduced costs, downtime, or waste.
- **Two Pitches:**
    - *Client pitch* — 2–3 sentences emphasizing practical value and usability.
    - *Investor pitch* — 2–3 sentences summarizing market need, sustainability relevance, and business logic.

This summary is displayed on-screen only and must be manually saved by the learner for later use or classroom presentation.

Added Value for Learners and Educators

For learners, the Value Shaper transforms earlier explorations into a **professionally structured value proposition**. It helps them practice the communication of complex ideas in simple, audience-oriented language—an essential competence for entrepreneurial learning and VET employability.

For educators, it provides **a clear and consistent output format** that demonstrates learners' progression from reflection (EduBot 1), through knowledge (EduBot 2), to idea development

(EduBot 3), and finally to communication (EduBot 4). The generated summaries can support peer review, class presentations, or formative assessment in innovation-related courses.

Position in the EduBot Sequence

The Value Shaper acts as the **culmination of the four-step EduBot pathway**:

- From **Change Explorer**, learners bring awareness of sustainability issues in their profession.
- From **Circularity Coach**, they gain structured knowledge of circular practices.
- From **Idea Builder**, they contribute a draft P2S concept and early feasibility reasoning.
- With **Value Shaper**, they convert this foundation into a **persuasive, audience-ready value proposition** integrating user insight and multi-dimensional impact.

By emphasizing clarity, user relevance, and evidence-based articulation, the Value Shaper completes the **competence loop** of the EcoInnovate AI+ framework—connecting sustainability thinking with communication, entrepreneurship, and practical application in vocational contexts.

4.2 Integration of P2S principles into EduBots design

The **Product-to-Service (P2S)** concept is the central organising principle of the EduBots framework. Each EduBot introduces and applies P2S thinking at a different level, so that learners gradually progress from understanding basic ideas to formulating and communicating their own service-based solutions. This approach ensures that the concept is not presented as theory alone but applied and reflected upon throughout the learning process.

Progressive P2S Integration Across the EduBots

1. **Change Explorer – Introduction and Reflection**

   Introduces the basic idea of replacing ownership with service-based access. Learners relate this shift to their own vocational field and develop a short statement describing what P2S could mean in their context.

2. **Circularity Coach – Contextualisation in the Circular Economy**

   Links P2S thinking to the circular economy by showing how service-based models support strategies such as reuse, repair, and remanufacture. Learners connect the idea of "using a service instead of owning a product" with resource efficiency and product longevity.

3. **Idea Builder – Application Through Service Pathways**

   Provides examples of different service models (e.g. Access-as-a-Service, Uptime-as-a-Service, Usage-based models). Learners select and adapt one or more of these pathways to outline a simple P2S idea relevant to their professional setting.

4. **Value Shaper – Synthesis and Communication**

   Guides learners in turning their draft idea into a concise value proposition. It helps them describe who the service is for, which problem it addresses, and what value it creates for users. The exercise concludes with a short, structured statement that captures the essence of the service idea.

The Value Proposition as Integrating Framework

The **value proposition** serves as the point where P2S principles come together. The short template — "*For [user] who [pain], our [P2S service] delivers [gains] by [how it works]*" — summarises the logic of service-based innovation:

- **Service logic:** Focus on access and performance instead of ownership.
- **Sustainability dimension:** Reduction of material use and extension of product lifecycles.
- **User relevance:** Direct orientation towards the needs and expectations of the intended users.
- **Economic dimension:** Recognition that service solutions must remain feasible within the given context.

This structure allows learners to describe their ideas clearly and to show how P2S principles are embedded in their design.

Cross-cutting P2S Themes in EduBots

- **Access instead of ownership:** Central concept repeated across all EduBots.
- **Lifecycle thinking:** Addressed in Circularity Coach and applied in later stages.
- **Systemic perspective:** P2S presented as part of a wider move towards circular and resource-efficient practices.
- **Entrepreneurial reasoning:** Learners consider the relationship between user needs, value creation, and implementation conditions.

Added Value of P2S Integration

The integration of P2S throughout the EduBots sequence ensures that learners gain a practical and coherent understanding of service-oriented innovation. By the end of the process, they can:

- Explain the main principles of P2S.
- Apply these principles to their own vocational area.
- Communicate a clear and concise service idea with a defined user and value perspective.

Through this progression, learners acquire skills relevant to both **sustainable practice** and **innovation in vocational contexts**, contributing to the goals of the green and digital transitions in VET.

4.3 Educational and technical robustness

The EduBots have been developed with balanced attention to **pedagogical soundness** and **technical reliability**, ensuring effective operation in varied Vocational Education and Training (VET) settings. Their robustness results from combining solid educational design, AI-based adaptability, and structured usability features that enable consistent learning outcomes.

Educational Robustness

1. Alignment with VET Competences

The EduBots are explicitly structured to strengthen competences central to contemporary vocational training and EU skills frameworks:

- **Green competences:** Understanding sustainability challenges, applying circular and resource-efficient practices, and designing environmentally responsible solutions.
- **Digital competences:** Engaging with AI-supported learning environments, strengthening digital literacy, and interacting effectively in virtual dialogue systems.
- **Entrepreneurial competences:** Developing user-focused ideas, exploring feasibility and service design, and articulating clear value propositions.
- **Systemic thinking:** Recognizing interconnections between environmental, social, and economic factors in sustainability-oriented decision-making.

2. Scaffolded Learning Pathway

Each EduBot is integrated into a **progressive four-stage learning sequence**, where knowledge and application build cumulatively:

- *Change Explorer* introduces sustainability reflection and P2S awareness.
- *Circularity Coach* provides structured understanding of circular principles.
- *Idea Builder* translates reflection and knowledge into applied service concepts.
- *Value Shaper* consolidates learning into a coherent and communicable value proposition.

This scaffolded design supports continuity and incremental competence growth, while producing intermediate learning artefacts at each stage.

3. Active and Reflective Pedagogy

The EduBots employ **interactive dialogue** instead of passive content delivery. Each interaction requires learners to reflect, make choices, and link new insights to their professional experience. This participatory approach fosters deeper understanding, transfer of knowledge to practice, and higher engagement compared to traditional instruction formats.

4. Structured Outputs as Learning Artefacts

Each EduBot produces a **structured textual output**—such as a reflection summary, list of circular practices, draft P2S concept, or final value proposition. These outputs serve as **learning artefacts** that can be reused in subsequent stages, integrated into classroom activities, or collected as evidence of learning progression.

Technical Robustness

1. AI-Powered Dialogue with Defined Parameters

EduBots use **GPT-based conversational AI** to support adaptive, natural language interactions. Each bot operates within clear predefined rules:

- One question per response to ensure focus.
- Rejection of unsafe or unethical requests.
- Consistent, age-appropriate, and jargon-free language.

These boundaries ensure **predictable, safe, and pedagogically appropriate** performance in educational environments.

2. Multilingual Accessibility

All EduBots are available in **three fully localized language versions** (English, German, Lithuanian). This ensures accessibility and inclusion across diverse VET contexts, enabling direct use without translation or adaptation by the learner.

3. Session Design for Usability

The EduBot sessions are designed to be **compact and manageable**, typically spanning 8–10 user inputs. Long or complex sections are divided into smaller parts with short continuation prompts (e.g., “Reply ‘1’ to continue”), which maintains focus and prevents cognitive overload.

4. Integration of Real-World Examples

Each EduBot includes **profession-specific examples** to demonstrate how sustainability and P2S principles apply across sectors. This contextualization increases relevance and helps learners transfer abstract ideas to their own professional practice.

5. Structured Output Generation

At the conclusion of each EduBot session, a **standardized text output** is generated (e.g., "Module Result," "Top 3 Reflection," "Idea Summary," "Value Proposition Pitch"). These outputs are formatted for easy saving and reuse in follow-up learning modules, ensuring continuity and traceability throughout the learner's pathway.

5 Functionalities and Alignment with VET Needs

The EduBots have been developed to support **Vocational Education and Training (VET)** in addressing current challenges related to **sustainability, digitalisation, and entrepreneurial competence development**. Their design combines pedagogical theory with practical usability, offering AI-supported learning environments that complement existing teaching rather than replace it.

EduBots function as **structured learning companions**: they guide learners step by step, promote reflection, and generate usable learning outputs that teachers can integrate into classroom practice. Their value lies less in technological novelty and more in their **educational functionality and alignment with VET learning processes**.

5.1 Key features of EduBots (interactive learning, feedback, simulations)

The EduBots share several **educationally significant features** that make them suitable for supporting VET learners across different subjects and professions.

Adaptive Dialogue Structure

EduBot operates primarily through a **guided dialogue format**, where learners progress step by step through a sequence of questions and reflections.

While the core design principle is *one main question per turn*, the EduBots can include **occasional short follow-up questions or clarifications** when necessary to maintain coherence or check understanding.

This ensures flexibility without losing the structured pacing that supports comprehension and reflection.

The adaptive questioning style allows learners to engage in natural conversation while still following a clear pedagogical pathway.

Progressive Sequencing

The EduBots follow a **scaffolded learning sequence** that mirrors progressive competence development in VET:

- **Change Explorer** – introduces sustainability and P2S awareness through reflection.
- **Circularity Coach** – provides structured knowledge via the 3P–10R framework.
- **Idea Builder** – enables creative application and simple service design.
- **Value Shaper** – helps refine ideas into concise, communicable value propositions.

Each step builds directly on the outputs of the previous one, ensuring pedagogical continuity and gradual competence growth.

Structured Learning Outputs

Every EduBot session concludes with a **structured text result**—such as a reflection summary, list of circular practices, draft service idea, or final value statement.

These outputs:

- Capture what the learner has produced during interaction.
- Serve as artefacts for discussion or further development in subsequent EduBots.
- Provide transparent evidence of individual progress and learning outcomes.

This aligns with **competence-based learning** principles, where visible results are used for formative feedback and assessment.

Contextualisation to Professions

EduBots continuously prompt learners to **apply sustainability and Product-to-Service (P2S)** concepts to their specific vocational field.

This ensures relevance across diverse training areas—such as construction, automotive, hospitality, or healthcare—and supports **transfer of knowledge** from abstract principles to concrete practice.

Critical Reflection

Dialogue prompts encourage learners to **analyse benefits and barriers**, identify potential risks, and evaluate trade-offs.

By engaging in guided reasoning, learners practice **critical and systems thinking**, which are essential competences for adapting sustainability concepts to real vocational contexts.

Multilingual Accessibility

All EduBots are implemented in **English, German, and Lithuanian** versions.

This multilingual approach ensures accessibility for all partner countries and inclusion of learners with varying language backgrounds, without relying on external translation tools.

Manageable Session Length

EduBot sessions are designed to last **between 8 and 10 user interactions on average**, depending on user input and the level of elaboration chosen (starter, intermediate, advanced).
This flexible length makes the sessions compatible with typical VET lesson durations and supports **modular integration** into classroom or blended learning settings.

Ethical Safeguards

The EduBots are programmed with **strict safety and ethical guidelines**.

They avoid unsafe or inappropriate topics, maintain a respectful tone, and promote responsible learning attitudes.

This ensures safe use in educational environments and aligns with EU principles of **ethical AI and values-based education**.

5.2 Relevance for learners, educators, and curricula

The educational relevance of the EduBots arises from their **alignment with the competence needs of learners**, the **pedagogical requirements of educators**, and the **structural objectives of VET curricula**.

Each group benefits in distinct yet complementary ways, ensuring coherence between individual learning, teaching practice, and institutional goals.

Relevance for Learners

For VET learners, the EduBots provide a **structured yet flexible learning environment** for exploring sustainability and Product-to-Service (P2S) principles. Their contribution can be summarised across four key dimensions:

- **Personalised learning:**

  EduBots prompt learners to connect sustainability and service innovation concepts directly to their vocational field. This personalisation strengthens engagement and supports knowledge transfer from abstract principles to real professional contexts.

- **Competence development:**

  The stepwise sequence promotes both domain-specific and transversal competences — including **sustainability awareness**, **digital literacy**, **problem-solving**, **critical thinking**, and **communication skills**.

- **Reflective learning:**

  The dialogical interaction encourages learners to articulate reasoning, consider alternatives, and justify decisions. This reflective process deepens understanding and fosters self-directed learning habits.

- **Creation of learning artefacts:**

  Each EduBot produces structured textual outputs — such as reflections, practice lists, or service ideas — which serve as **evidence of learning progress**. These can be reused for project work, assessments, or portfolio development.

Relevance for Educators

For educators, trainers, and facilitators, the EduBots act as **practical tools for embedding sustainability and innovation** into teaching practice. Their value lies in their ease of integration and support for evidence-based pedagogy:

- **Pedagogical alignment:**

  The modular and stepwise structure of each EduBot mirrors effective lesson design and can be implemented as a short standalone exercise or within broader project-based learning settings.

- **Reduced preparation workload:**

  EduBots include pre-designed prompts, examples, and reflection tasks that can be used directly, enabling educators to focus on facilitation and feedback rather than extensive content preparation.

- **Formative assessment support:**

  Learner-generated outputs (e.g., summaries, lists, or value propositions) can be reviewed by teachers to monitor progress, guide discussions, and provide targeted feedback.

- **Differentiation and inclusion:**

  The adaptive interaction style allows students with varying prior knowledge and language proficiency to engage meaningfully at their own pace, supporting inclusive and differentiated teaching approaches.

Relevance for Curricula

At the systemic level, the EduBots align with **European VET policy priorities** and can be integrated into diverse vocational programmes without major curriculum modification. Their contribution includes:

- **Alignment with EU priorities:**

  EduBots address strategic objectives related to the **green transition**, **digital transformation**, and **entrepreneurial learning**, as outlined in the European Skills Agenda and the Council Recommendation on VET (2020).

- **Integration of transversal competences:**

  The EduBots develop skills that are transferable across professions — including **digital competence**, **initiative and innovation**, and **systemic sustainability awareness** — supporting lifelong learning objectives.

- **Cross-sector adaptability:**

  Because each EduBot contextualises tasks to specific vocational fields (e.g., construction, hospitality, health, or design), they can be applied flexibly across sectors without altering core content.

- **Support for competence-based pedagogy:**

  Their design reflects current shifts toward **learner-centred, competence-oriented, and output-based education**, reinforcing modern pedagogical standards promoted across EU VET systems.

6 Expected Impact and Next Steps

The EduBots are designed to deliver measurable benefits across three key levels of the vocational education and training (VET) system: **learners**, **educators**, and **institutions**. Their anticipated impact extends beyond individual competence development to the broader objectives of VET modernisation, contributing to the **green and digital transitions** and to the strengthening of entrepreneurial and systemic competences in vocational learning environments.

6.1 Anticipated benefits for learners, educators, and institutions

Learners

For learners in VET, the EduBots act as guided digital learning companions that support active engagement, reflection, and skill development. The expected benefits include:

- **Enhanced understanding of sustainability and P2S principles**, contextualised to vocational practice rather than presented as abstract theory.
- **Acquisition of transversal competences**, including digital literacy, systemic and critical thinking, entrepreneurial initiative, and communication skills.
- **Active learning experiences**, as the interactive dialogue format requires learners to make decisions, justify choices, and connect ideas to their professional field.
- **Creation of tangible learning artefacts**—reflections, lists of circular practices, draft P2S ideas, or concise value propositions—that can be used as project material or competence evidence.
- **Improved confidence in applying sustainability principles**, articulating innovative ideas, and understanding the logic of service-oriented business models relevant to their profession.

Educators

For teachers and trainers, the EduBots provide practical pedagogical support tools that facilitate the integration of sustainability and innovation into VET programmes. The main advantages are:

- **Structured teaching resources**, including prompts, examples, and guided tasks aligned with sustainability, circularity, and innovation objectives.
- **Flexible integration into different teaching formats**, from short classroom exercises to blended or project-based learning modules.
- **Support for differentiation**, enabling learners with varying levels of knowledge or digital readiness to progress at their own pace.

- **Facilitation of formative assessment**, as learner-generated outputs provide clear insight into understanding, reasoning, and skill development, which can be reviewed and discussed in class.

- **Reduction of preparation workload**, since EduBots provide pre-structured dialogue sequences and content scaffolding aligned with curricular goals.

Institutions

For VET institutions, EduBots contribute to the modernisation of teaching and learning by embedding sustainability and digitalisation principles within existing curricular structures. Institutional-level benefits include:

- **Support for curriculum innovation**, enabling integration of green and digital competences without extensive curriculum redesign.

- **Alignment with European policy frameworks**, particularly the *European Green Deal*, *Digital Education Action Plan (2021–2027)*, and *Council Recommendation on VET for sustainable competitiveness and inclusion*.

- **Scalability and accessibility**, as EduBots can be implemented across professions, sectors, and languages, suitable for both individual and group learning settings.

- **Enhanced institutional visibility and innovation profile**, demonstrating engagement with competence-based, learner-centred, and technologically supported pedagogy.

- **Potential for long-term sustainability**, as the EduBot design supports replication, adaptation, and further development within different educational or training contexts.

6.2 Transition to ACT.3: Pilot testing and refinement

The conceptual framework developed in **ACT.2** forms the foundation for the next phase, **ACT.3 (Pilot Testing and Refinement)**. This stage represents the critical transition from design to validated educational practice, ensuring that the EduBots are not only theoretically sound but also effective, usable, and pedagogically relevant in real VET environments.

Objectives of ACT.3

The pilot phase aims to systematically test and improve the EduBots based on empirical evidence from classroom and training use. The main objectives are:

- **Validation of functionality:**

  Confirm that EduBots operate reliably across multiple contexts, languages, and vocational sectors, ensuring stable performance and accessibility.

- **Evaluation of educational impact:**

  Assess the extent to which EduBots foster competence development in key areas such as sustainability awareness, digital literacy, entrepreneurial thinking, and systemic reflection.

- **Collection of user feedback:**

  Obtain qualitative input from learners and educators regarding usability, clarity of instructions, and perceived learning relevance.

- **Refinement of content and interaction:**

  Adjust prompts, examples, and interaction structures in response to feedback and observed learner needs, ensuring continuous improvement.

Pilot Settings

Pilot testing will be conducted with **VET learners and educators in partner institutions in Austria and Lithuania**. The EduBots will be integrated into existing training modules and lesson plans, ensuring that testing occurs under realistic teaching and learning conditions. The availability of **English, German, and Lithuanian versions** allows for comparative insights into language-specific learner experiences and the consistency of educational outcomes.

Data Collection and Evaluation

Evaluation will employ a **mixed-methods approach**, combining qualitative and quantitative data to capture both performance metrics and user experiences:

- **Learner surveys and focus groups:** To assess engagement, clarity, perceived usefulness, and motivation.
- **Educator feedback:** To evaluate pedagogical integration, lesson compatibility, and workload implications.
- **Analysis of learning artefacts:** Review of learner outputs (reflections, circularity practices, draft ideas, value propositions) as indicators of competence acquisition and progression.
- **Usage data analysis:** Examination of anonymised session data (interaction counts, duration, common stopping points) to identify learning patterns, usability issues, and areas for optimisation.

Expected Refinements

Insights from the pilot phase will inform iterative improvements in both educational and technical design. Anticipated refinements include:

- **Content adjustments:** Simplifying or extending examples to better match different vocational fields and learner profiles.
- **Interaction flow:** Fine-tuning the balance between session length and cognitive load to align with typical classroom durations and learner attention spans.
- **Support materials:** Developing concise **educator guidelines and implementation notes** to facilitate lesson planning and integration into curricula.
- **Technical improvements:** Enhancing stability, accessibility, and compatibility across devices and user interfaces to ensure reliable operation in various educational settings.

Link to Broader Project Goals

The pilot testing phase serves a dual purpose:

1. **Validation and refinement** of the EduBots as functional, pedagogically sound tools; and
2. **Preparation for scaling and mainstreaming** within vocational education systems.

Findings from ACT.3 will contribute to the project's dissemination and exploitation activities by providing **evidence of effectiveness**, **recommendations for integration**, and **guidelines for future adoption** across VET institutions.

References and further readings

Aeddula, O.K., Melen, C.T., Scurati, G.W., Larsson, T., West, S., Wall, J. (2025). AI-Powered Value Co-Creation: A Case Study Approach to Smart PSS Development. In: West, S., Meierhofer, J., Buecheler, T., Wally Scurati, G. (eds) Smart Services Summit. SMSESU 2024. Progress in IS. Springer, Cham. https://doi.org/10.1007/978-3-031-86958-7_5

Kohtamäki, M., Brekke, T., Naeem, R., Sjödin, D., Parida, V. (2025). Managerial practices shaping the transformation toward AI-enabled product–service systems. International Journal of Production Economics, 286, 109658. https://doi.org/10.1016/j.ijpe.2025.109658

Naeem, R., Kohtamäki, M., & Parida, V. (2024). Artificial intelligence enabled product–service innovation: Past achievements and future directions. Review of Managerial Science. https://doi.org/10.1007/s11846-024-00757-x

EcoInnovateAI+

THE CRITICAL

2334 HAFELEKAR

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the National Agency. Neither the European Union nor National Agency can be held responsible for them.