



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



**Project title: Advancing Green Agricultural Entrepreneurship in
Secondary VET Schools**

Acronym: Green Agripreneurs

**IO 1. Teacher manual “Implementation
of Design Thinking and Problem Based
Learning Methodology in designing and
implementation of sustainable
agricultural projects**

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Module 1. The concept of Implementation of Sustainable Agriculture in VET schools

INTRODUCTION

Sustainability has become an urgent educational priority in light of global environmental challenges, food insecurity, and the pressing need to prepare future generations for responsible stewardship of natural resources. Integrating sustainable agricultural practices into school curricula is not only essential for achieving ecological and economic balance but also for equipping students with the skills and mindsets necessary for shaping resilient food systems.

The Module 1 from this guidebook is designed for teachers, particularly those in Vocational Education and Training (VET) and general secondary education, who wish to introduce or strengthen sustainability themes through agriculture. It highlights pedagogical strategies, curriculum integration, and student-led best practices that turn schools into living laboratories of sustainability. The focus is on experiential learning, community engagement, and transdisciplinary approaches that link theory with meaningful action.

1. AGRICULTURE AND SUSTAINABILITY

1.1. How to understand sustainable agriculture?

Sustainable agriculture encompasses practices aimed at enhancing productivity while preserving environmental health and social equity. To fully grasp its significance and implications, it is essential to consider the multifaceted approaches that define sustainable farming practices, their socio-economic impacts, and the factors influencing their adoption.

Firstly, sustainable agriculture has been identified as a catalyst for increased agricultural productivity, particularly in contexts where traditional methods prevail. For instance, Sikandar et al. (2022) emphasize the positive correlation between sustainable practices and agricultural output, perceiving that transitioning from conventional to sustainable methods significantly benefits production, particularly in developing countries struggling with lower yields due to outdated techniques. This aligns with findings from the literature, which assert that sustainable practices, such as integrated pest management and resource-conserving technologies, not only enhance productivity but also contribute to environmental conservation by minimizing harmful inputs (Pretty et al., 2005).

Moreover, specific sustainable practices, such as crop rotation, agroforestry, and the use of organic fertilizers, demonstrate tangible benefits in addressing food security and ecological risks. For example, Tsiouni et al. (2021) report that farms accessing advisory services often adopt innovations that lead to more sustainable outcomes, indicating the crucial role of education and knowledge dissemination in facilitating such transitions. This notion is further supported by Ojadi (2024), who explores the importance of soil management in sustainable practices, reinforcing the idea that understanding and nurturing the soil is vital for long-term agricultural benefits.

Sustainable agriculture involves farming practices that are environmentally friendly, economically viable, and socially responsible. These practices include:

- Preserve soil fertility and structure;
- Reduce water consumption and pollution;
- Minimise greenhouse gas emissions;

- Promote biodiversity;
- Encourage local food systems and food sovereignty.

Climate change poses significant challenges that necessitate the implementation of sustainable practices. Samir (2023) discusses how sustainable agricultural techniques will become essential strategies in regions like Morocco to adapt to adverse climate impacts, thereby highlighting the role of sustainable agriculture in enhancing climate resilience. Similarly, extensive research indicates that managing natural resources sustainably is integral to coping with environmental variability, particularly in regions affected by climate change, as highlighted in the studies on agricultural practices in Nigeria (Amankwah, 2023).

Another adaptation to climate change in agriculture is carbon farming. Carbon farming represents a set of agricultural strategies aimed at sequestering carbon dioxide from the atmosphere, thereby mitigating the impacts of climate change while enhancing the sustainability of agricultural practices. As climate change continues to pose significant threats to agricultural productivity and food security globally, the adoption of carbon farming practices is becoming increasingly relevant within sustainable agriculture frameworks.

One of the central components of carbon farming involves implementing practices that enhance soil health and carbon storage. Techniques such as agroforestry and cover cropping have been shown to significantly increase the soil's ability to sequester carbon and improve overall soil fertility (Ghosh et al., 2024). This capacity for enhanced carbon storage contributes to climate change mitigation and supports improved crop resilience against environmental stresses, such as droughts and floods induced by a changing climate (Singh et al., 2024). Furthermore, Ghosh et al. (2024) discuss how such practices boost biomass production, which serves to reinforce the agricultural ecosystem's resilience against shifting climatic conditions.

Research indicates that carbon farming can offer additional economic and ecological benefits that align with sustainable agriculture goals. Evans et al. (2015) note that assisted natural regeneration as a carbon farming approach can restore biodiversity in agricultural landscapes, thus improving the ecological integrity of farming systems while providing long-term carbon sequestration benefits. The integration of carbon farming practices is thus not only a tool for reducing greenhouse gas emissions but also a pathway to enhancing ecosystem services that agriculture relies upon.

Despite its advantages, barriers to the widespread adoption of carbon farming remain prevalent. Economic incentives and policy frameworks are crucial in driving farmer participation in carbon offset programs. Singh et al. (2024) emphasize the need for agricultural policies to support a transition toward climate-resilient practices through investments and incentivization of carbon farming initiatives. Current agricultural systems often prioritize short-term productivity over long-term sustainability benefits, complicating farmers' willingness to adopt carbon farming practices.

Moreover, livestock and poultry farming emit significant greenhouse gases, and hence, integrating carbon farming principles in livestock management is essential (Ubolsook et al., 2024). For instance, implementing mixed crop-livestock farming systems can lead to reduced emissions by optimizing resource use across production systems (Wiesner et al., 2020). By adopting practices that limit greenhouse gas emissions from livestock farming, such as improving manure management and dietary interventions, it is possible to significantly decrease the agricultural sector's overall carbon footprint (Lozano et al., 2017).

In addition to direct agricultural practices, climate change continues to alter the external pressures on agricultural systems, as noted by Mendelsohn (2014), who indicates that climate variability is expected to exert considerable stress on crop yields and livestock production, thus exacerbating food security issues in vulnerable regions. This interplay between climate change and agriculture underscores the need for innovative strategies such as carbon farming, which can help mitigate these challenges while boosting agricultural sustainability.

Carbon farming stands as a transformative approach within sustainable agriculture, bridging the need for climate change mitigation with practical farming solutions. Emphasizing practices that not only sequester carbon but also enhance soil health and ecosystem resilience offers a pathway toward achieving both environmental and economic sustainability in agriculture. Therefore, promoting policies that support the adoption of carbon farming practices is vital in facilitating this transition to a more sustainable agricultural future.

Age, education, and social dynamics critically influence the uptake of sustainable practices among farmers. For instance, Ji et al. (2022) illustrate a direct relationship between the age and marital status of farmers and their likelihood of adopting sustainable methods, emphasizing how socio-demographic factors can either enhance or hinder the adoption process. Concurrently, Hameed and Sawicka (2023) emphasize the necessity of agricultural extension services in promoting sustainable agriculture, as insufficient information and managerial skills can significantly impede adoption. The participatory approach that integrates local knowledge and modern techniques exemplifies sustainable agriculture's ethos.

In conclusion, sustainable agriculture is not merely an alternative farming method; it is a comprehensive approach integrating environmental, economic, and social dimensions. The synergy between improved agricultural practices and the socioeconomic context in which they are embedded is pivotal for achieving long-term sustainability goals. Supporting farmers through education, access to resources, and adaptive practices forms the cornerstone of a resilient agricultural future. In an educational context, sustainable agriculture provides a rich, real-world context for learning biology, environmental science, technology, business, ethics, and citizenship. Students not only learn how food is grown but also why it is grown.

1.2. Why should vocational schools teach sustainable agriculture?

Schools are ideal environments for modelling sustainable practices and promoting eco-literacy. Teaching sustainable agriculture in vocational schools is crucial for fostering an environmentally responsible workforce that can effectively address contemporary agricultural challenges, particularly those related to climate change. This educational focus aligns with the broader goals of promoting green skills, enhancing food security, and ensuring economic viability within agricultural settings.

First and foremost, sustainable agriculture education enhances students' comprehension of ecological principles essential for modern agricultural practices. As highlighted by Handayani et al. (2021), integrating green skills into the vocational education curriculum is crucial, as these skills directly contribute to sustainable practices and technologies in agribusiness. This integration equips students with relevant knowledge and fosters an awareness of environmental issues, preparing them to implement sustainable practices that reduce ecological footprints across farms and agribusiness operations. The need to incorporate ecological and sustainability concepts into vocational training is echoed by Jomegi et al. (2024), who assert that aligning curriculum development with climate-smart agriculture can prepare students for contemporary agricultural realities marked by environmental instability.

Moreover, vocational education in sustainable agriculture creates a pipeline for skilled labour equipped with green competencies. In the context of growing global urgency around ecological sustainability, vocational graduates must develop green skills as part of their training to thrive in a green economy (Handayani et al., 2020a). This is particularly relevant as agricultural sectors increasingly demand workers who can leverage environmentally friendly technologies and practices. Training in sustainable agriculture not only empowers students with technical know-how but also enhances employability in a job market increasingly focused on sustainability and ethical practices.

Engaging students through experiential learning strategies can enhance their understanding of sustainable agricultural practices. Cakrawati et al. (2015) suggest that agricultural vocational curricula should incorporate hands-on experiences where students can directly engage with agricultural systems, thus fostering a deeper understanding of the biological, chemical, and physical sciences that underpin sustainable agriculture. By learning through direct experience, students are more likely to internalize sustainable practices and apply them in real-world settings, creating a workforce capable of leading in the sustainable agricultural sector.

Furthermore, addressing local and global challenges through a sustainable agriculture curriculum can significantly enhance vocational education's relevance. There is a necessity to adapt vocational educational curricula to reflect the dynamic nature of agricultural practices in response to climate change and technological advancement. This adaptability ensures that students learn current, applicable knowledge vital for maintaining food security and environmental sustainability in their future careers.

Finally, the incorporation of sustainable practices into vocational education not only educates future agricultural professionals but also contributes to community resilience against climate change. As cited by Mahasneh (2014), educational programs must aim to prepare students not just for individual careers but to be active, informed citizens capable of contributing to broader societal goals, including environmental stewardship. This holistic approach cultivates a generation of environmentally literate individuals who can advocate and implement sustainable practices at local, national, and global levels.

Integrating sustainable agriculture into vocational school curricula will address the complexities of modern agricultural challenges:

- Cultivates environmental awareness and responsibility;
- Encourages healthy eating and food literacy;
- Supports project-based and inquiry-based learning;
- Fosters cross-disciplinary competencies (science, math, digital skills, entrepreneurship);
- Strengthens ties with local communities and food producers.

By fostering green skills, promoting experiential learning, and adapting to local and global agricultural needs, vocational schools can play a crucial role in shaping a sustainable future for agriculture and ensuring food security in a rapidly changing world. Schools that successfully implement sustainable agriculture often transform underutilised spaces into gardens, greenhouses, or composting systems, making sustainability visible and tangible.

1.3. What are effective curriculum integration strategies for sustainable agriculture?

Integrating sustainable agriculture into school curricula is essential for nurturing a generation that values environmental stewardship and sustainability in agricultural practices. Effective integration strategies not only enhance students' understanding of agricultural concepts but also equip them with practical skills necessary for addressing contemporary challenges in food production and environmental care. These strategies collectively ensure that students acquire critical knowledge, skills, and values associated with sustainable agriculture, preparing them to become responsible stewards of the environment. School curriculum integration strategies for sustainable agriculture should be multidimensional, employing interdisciplinary methods, experiential learning, collaboration, comprehensive curriculum revisions, stakeholder engagement, and leadership development. Several strategies can be employed to facilitate this integration.

a) Interdisciplinary approaches (cross-curricular links)

Implementation of Design Thinking and Problem-Based Learning Methodology in designing and implementation of sustainable agricultural projects

Integrating sustainable agriculture into various subject areas encourages students to see the connections between agriculture, ecology, economics, and social studies. Vallera and Bodzin (2016) emphasize the importance of aligning agricultural literacy with established educational standards. By embedding agricultural concepts into broader subjects, educators can promote agricultural awareness as a multi-dimensional topic. This approach helps students recognize the relevance of sustainable practices beyond traditional agricultural education, fostering critical thinking about the environmental impacts of agricultural activities across subjects. Sustainable agriculture can be integrated across subjects:

- Science: Soil chemistry, photosynthesis, pest management;
- Geography: Land use, climate impacts on agriculture;
- Math: Measuring growth rates, yields, and data collection;
- ICT: Smart farming, sensors, data tracking, GIS mapping;
- Entrepreneurship: Business plans for local produce, social enterprises;
- Civic Education: Ethics of food production, fair trade.

By connecting agriculture education with subjects such as biology, geography, and environmental science, students develop a comprehensive understanding of the environmental implications of agricultural practices. This approach not only enhances cognitive development but also fosters an attitude of responsibility among students towards ecological stewardship.

b) Collaborative problem-solving (thematic units)

Utilizing project-based learning allows students to collaboratively tackle real-world issues related to sustainable agriculture. Several approaches engage students in projects requiring them to apply their knowledge in practical scenarios while incentivizing critical thought and community interaction (Birdsall, 2010). For instance, students could work on projects addressing local agricultural challenges such as soil erosion or water conservation, thereby learning sustainable practices through practical engagement. Also, interdisciplinary modules can be created around themes such as:

- From seed to table;
- Climate change and farming;
- Waste Not: Composting and the circular economy;
- Urban gardening and food justice.

c) Experiential Learning

Hands-on experiences are vital for effective learning in agriculture. Cakrawati et al. (2015) highlight the importance of experiential learning in vocational education, where students engage directly with agricultural practices, reflecting on their experiences and developing solutions. Schools can implement community gardens, farm-based learning experiences, and local field trips as practical applications of sustainable agriculture concepts, allowing students to observe and participate in sustainable techniques firsthand. This method not only reinforces theoretical knowledge but also cultivates practical skills that are crucial for careers in agriculture.

There can be created living classrooms through gardens or microfarms where students can:

- Grow and monitor crops;
- Conduct experiments on soil types and fertilizers;
- Explore pest control alternatives (e.g., companion planting);
- Manage compost and rainwater systems.

d) Fostering Leadership in Sustainability

As future leaders in agriculture, students must develop skills to advocate for sustainable practices within their communities and industries. Rizvi (2015) discusses the role of transformative

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pedagogies in preparing educators to embody teaching approaches that significantly impact learners. This transformative approach encourages students not only to understand sustainable agriculture but also to foster practices that advocate for environmental stewardship and social responsibility.

1.4. What are effective pedagogical approaches for sustainability education?

Veinović (2017) advocates revising curricula to integrate sustainability across subjects rather than treating it as an isolated topic. This systemic change ensures that sustainability becomes woven into the educational fabric, aligning with the holistic approach necessary to address complex environmental challenges. By establishing sustainability as a common theme throughout the curriculum, educators can foster a mindset among students that prioritises sustainable decision-making in their future careers. Developing educational content that emphasises not just the "what" but also the "how" of sustainable agriculture helps prepare students for future challenges. Staden (2020) points out the necessity of including emerging agricultural topics such as climate-smart practices and conservation methods in the curriculum. This inclusion ensures that students acquire relevant skills and knowledge, enabling them to adapt to changing agricultural landscapes and technology. The following are several pedagogical methods that can be practiced when teaching sustainable agricultural practices.

a) Project-Based Learning (PBL):

Allow students to investigate real agricultural challenges, such as:

- Designing an irrigation system;
- Creating organic pest control solutions;
- Developing a zero-waste food production model.

b) Inquiry-Based Learning

Pose essential questions like:

- How can we grow food sustainably in our local environment?
- What's the carbon footprint of our lunch?
- How do agricultural practices differ across cultures?

c) Experiential and Outdoor Learning

Get students outside to engage directly with the land. Activities may include:

- Soil testing and classification;
- Building raised beds or compost bins;
- Constructing a solar-powered greenhouse;

d) Student Agency and Voice

Encourage students to take leadership roles in sustainability initiatives:

- Student "Green Teams"
- School garden managers
- Sustainability reporters/bloggers
- Peer educators and workshop facilitators

1.5. How can challenges in sustainable agricultural education be overcome?

Sustainable agricultural education is fundamental to developing a workforce equipped to address the pressing challenges of food production, environmental protection, and socioeconomic sustainability. These challenges are complex, multifaceted, and often interrelated, necessitating a comprehensive exploration of pedagogical strategies, stakeholder collaboration,

and the integration of contemporary agronomy into educational frameworks. The underlying issues that hinder the effectiveness of agricultural education can be broadly categorized into three areas: pedagogical constraints, systemic challenges, and perceptions of agricultural practices among stakeholders.

Firstly, pedagogical approaches significantly influence the teaching and learning of agriculture in educational institutions. Research indicates that traditional methods often fall short in engaging students with the dynamic and interdisciplinary nature of sustainable agriculture. Emphasizing active learning, experiential exercises, and hands-on training can vitalize agricultural curricula, adapting to contemporary challenges such as climate change and market demands (Schroeder et al., 2006). This approach entails a departure from merely theoretical knowledge to more applied learning experiences that encourage problem-solving and critical thinking in real-world contexts.

Moreover, pedagogy must be inclusive of ecological principles and the social sciences. A broader educational focus that encompasses the socio-economic and environmental dimensions of agriculture is essential for fostering a comprehensive understanding of sustainable practices (Francis et al., 2001). Integrating research methods and learning objectives from social sciences into the agricultural education curriculum allows for a more holistic view, equipping students to tackle the intricate realities of food production and distribution.

The systemic challenges within agricultural education also warrant attention, particularly regarding the accessibility of resources and the establishment of collaborative networks among educators, policymakers, and community stakeholders. Limited access to capital, land, and extension services has been identified as barriers to students' and practitioners' enthusiasm for engaging in agribusiness (Owoade, 2020). Initiatives aimed at strengthening extension services can enhance the dissemination of knowledge and afford farmers the necessary support to adopt sustainable practices. These barriers not only pertain to material resources but also to educational infrastructures, with innovative systems such as online educational repositories serving as valuable resources for agricultural learning (Costopoulou et al., 2011).

Additionally, the integration of technology in agricultural education plays a pivotal role. The dissemination of information through digital platforms can enhance learning opportunities and make agricultural content more readily accessible, particularly in remote or underserved areas. Developing agricultural educational repositories enables the storage, reuse, and sharing of learning resources, thereby promoting broader agricultural literacy.

Furthermore, the role of extension agents within agricultural education is crucial. Research indicates that extension agents' perceptions and attitudes towards sustainable agriculture significantly influence their effectiveness in disseminating these concepts to farmers (Chizari et al., 1999). Training programs for extension agents that address their skepticism and enhance their competencies can lead to better outcomes in educating farmers about sustainable practices. Without the conviction of educators and extension professionals, the potential for implementing effective agricultural education diminishes significantly.

The perceptions held by educators and students regarding agricultural practices significantly affect engagement with sustainable agriculture. Research indicates that misconceptions or negative attitudes towards sustainable practices can hinder their adoption. For instance, educators and students exhibited varying levels of positivity towards sustainable agriculture, highlighting the need for curricula that explicitly address these perceptions and misconceptions.

Moreover, the identity and professional development of agriculture teachers play profound roles in shaping educational outcomes. A teacher's professional identity influences their approach to agriculture education, which subsequently impacts their students' learning experiences (Shoulders, 2018). The lack of a clear and supportive professional identity can lead to disengagement from innovative educational strategies, thus perpetuating traditional and possibly outdated pedagogical practices.

To address these issues, it is imperative to develop a unified and forward-thinking agricultural educational framework that includes interdisciplinary themes and fosters collaboration among all stakeholders involved in the education process. Emphasizing the integration of agroecological principles can help illustrate the value of sustainable practices and their impact on environmental and economic stability. This involves reinforcing the relevance of agricultural education to contemporary issues and aligning curricula with the realities faced in the agricultural sector.

To overcome these challenges, a multifaceted approach that incorporates both practical and theoretical perspectives is necessary. Continuous needs assessment processes must be integrated into agricultural education, ensuring that educational content remains relevant and effective in addressing emerging challenges in the sector. Improving access to rural development programs and governmental support can significantly enhance students' perspectives on agricultural careers, thereby increasing enrollment and engagement in agricultural education (Owoade, 2020).

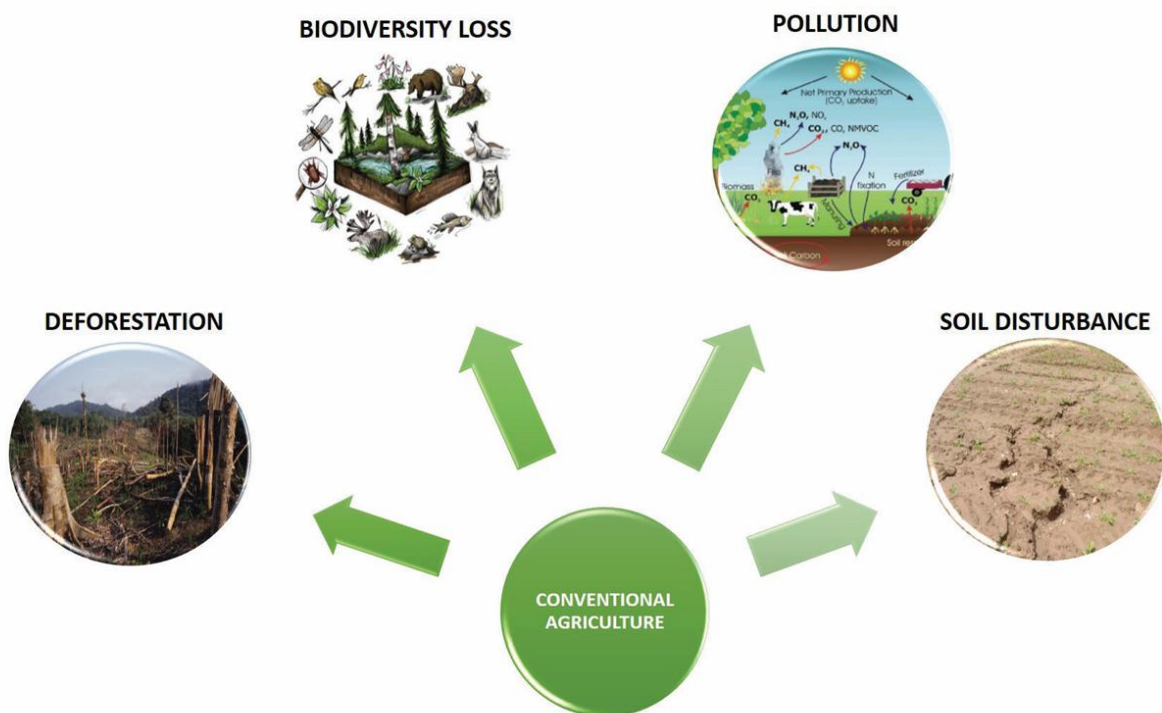
Incorporating elements of local food systems and citizen science can empower communities to engage with agriculture in meaningful ways, blending educational initiatives with local sustainability goals (Lacy, 2022). Encouraging student-driven projects that address real-world agricultural challenges can foster a sense of ownership and leadership among learners, aligning their academic pursuits with a commitment to sustainability.

In conclusion, the challenges of sustainable agricultural education are numerous and complex, ranging from pedagogical constraints to systemic barriers and perceptions among stakeholders. However, through collaborative efforts, innovative approaches to learning, and an emphasis on real-world applications, these challenges can be addressed. It is essential to view agricultural education as a vital component of broader societal goals, namely food security, environmental stewardship, and economic viability, thereby ensuring that future generations are equipped to face the agricultural challenges ahead comprehensively and innovatively.

2. IMPORTANCE OF IMPLEMENTATION OF SUSTAINABLE AGRICULTURE IN VET SCHOOLS

2.1. Understanding sustainable agriculture in the context of VET

Sustainable agriculture practices are crucial for ensuring food security, preserving environmental integrity, and promoting social welfare. Among these practices, organic farming has emerged as a crucial method for achieving sustainability in agriculture. Organic farming is characterized by its avoidance of synthetic fertilizers and pesticides, its emphasis on biodiversity, and its commitment to soil health, which collectively contribute to a more sustainable agricultural system (Perpar & Udovč, 2020; Sapbamrer & Thammachai, 2021). The implementation of organic farming practices leads to the enhancement of soil fertility and the minimization of environmental degradation. For instance, organic farming systems typically utilize methods such as crop rotation, composting, and the application of natural fertilizers to enhance soil productivity and maintain ecological balance (Darnhofer et al., 2010; Lee et al., 2015). This has been supported by findings that demonstrate organic farming's potential to increase soil organic matter and biodiversity while also providing essential ecosystem services that are often compromised in conventional farming systems (Meemken & Qaim, 2018).



Scheme 2.1. Impact of conventional agriculture on the environment

Environmentally sustainable agriculture is crucial for both future production as well as for the broader environment. The twenty-first century faces threats to global food supplies linked to environmental degradation. Industrial agriculture, based on fossil fuels, has contributed significantly to climate change, water and soil pollution, the lowering of water-tables, salinization of land and the loss of biodiversity. These costs have been externalized in the drive for high yields, profit and low food prices. Business as usual, i.e. industrial agriculture damages the resource base on which it depends. Industrial agriculture aims for the highest

Implementation of Design Thinking and Problem-Based Learning Methodology in designing and implementation of sustainable agricultural projects

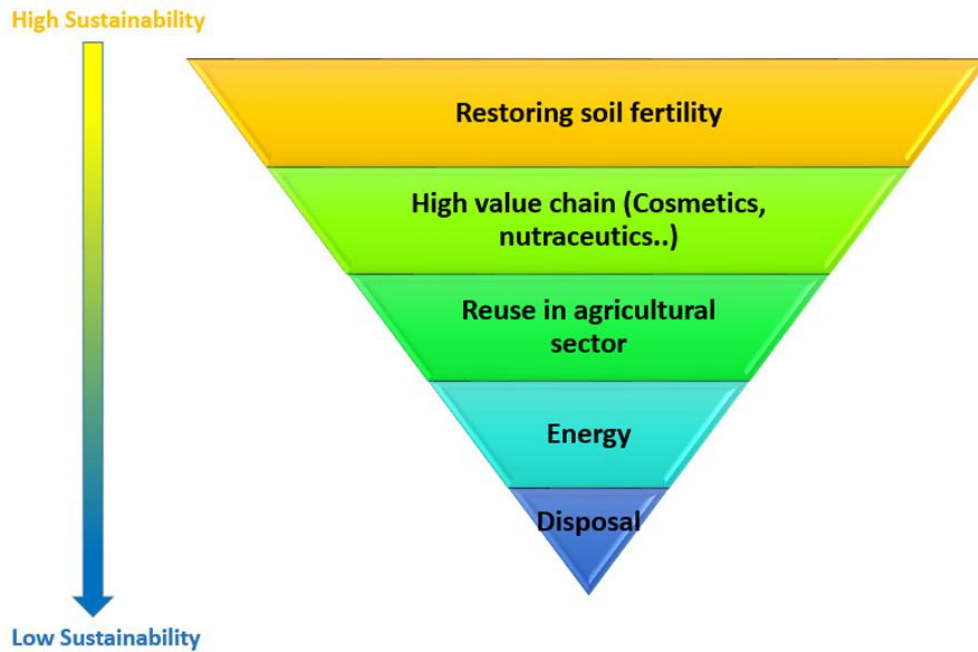
economic yields and maximum profit. Its underlying principles are simplification of ecosystems and large-scale production to achieve greater efficiency. The farmer is not held responsible for social and environmental impacts beyond the farm boundary. High inputs are required, including mechanization, petrochemical-based fertilizers and pesticides and hybrid or genetically modified seed. Strategies include intensive animal production and monoculture (Dumanski et al., 2006; Scherr & McNeely, 2008).

Table 2.1. Differences between conventional and sustainable agricultural systems

Conventional Systems	Sustainable Systems
Centralization	Decentralization
Dependence	Independence
Competition	Cooperation
Dominance over nature	Harmony with nature
Specialization	Diversity
Exploitation	Stewardship
Quantity	Quality
Profitable production	Ethical production
Reductionism	Holism

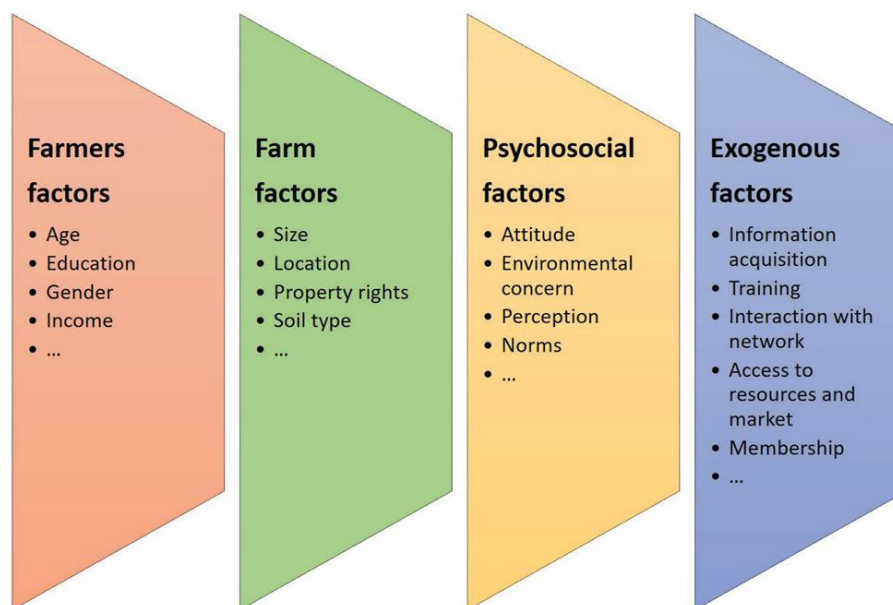
Sustainable agriculture emerged in the 1980s in response to concerns about industrial agriculture. The concept is contested. It ranges from weak to strong sustainable agriculture, depending on the level of challenge to industrial agriculture. Strong sustainable agriculture aims to transform the broad agri-food system, while weak sustainable agriculture attempts to modify but not replace industrial agriculture. Objectives include minimizing agricultural pollution and resource depletion, reducing energy use and conservation of soil, water and biodiversity including natural habitats as well as engaging in an interdisciplinary way with alternatives to the global capitalist food system (Francis, 2005; Wezel et al., 2009). Sustainable agriculture methods could increase production at the same time as protecting natural resources (Tirado, 2009). Farmers could play a significant role in conserving the environment through sustainable practices. Sustainable agriculture means farming in a way that meets the current needs for food and fibre while protecting the environment and natural resources for future generations. It's about long-term viability, not just maximizing short-term yields, and involves practices that enhance soil health, conserve water, and reduce reliance on synthetic inputs like pesticides and fertilizers.

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Scheme 2.2. Waste management in agriculture

Researchers claim that the adoption of sustainable agriculture practices may strengthen people's resilience to climate change, help mitigate soil degradation, and support agricultural output in a cost-effective, productive, and lucrative manner (Wollni & Andersson, 2014; Ngwenya et al., 2017; Aryal et al., 2020). The acceptance of novel agricultural techniques among farmers depends on variables that can be categorized into 4 groups as shown in Scheme 3.

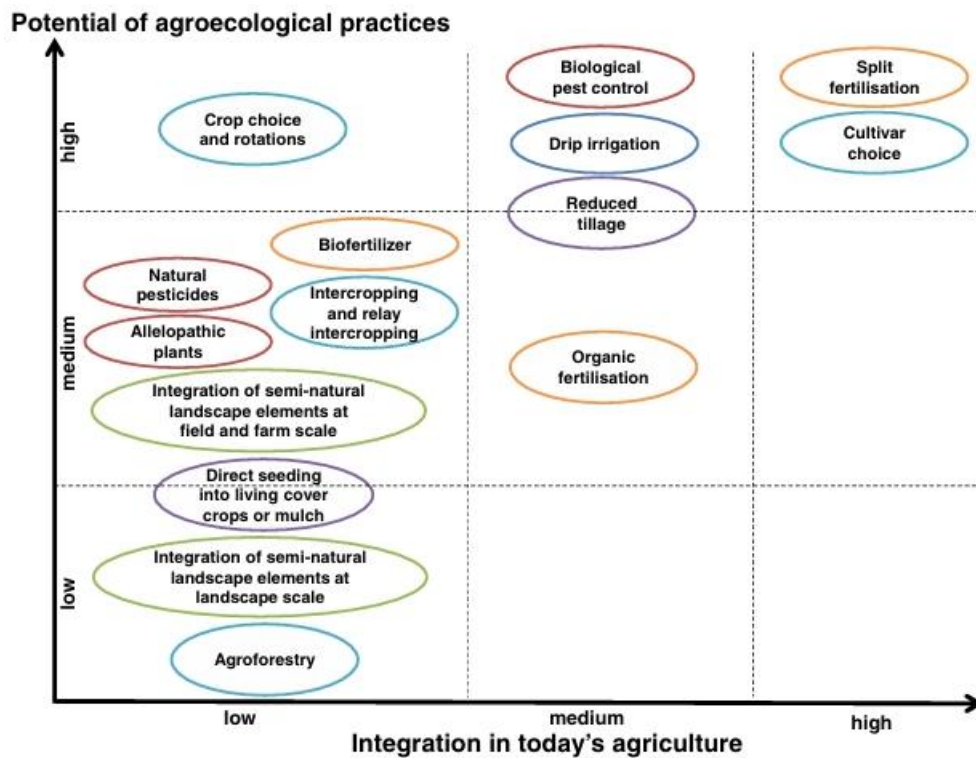


Scheme 2.3. Factors affecting the adoption of sustainable agriculture practices

Regenerative agriculture is another term that has become popular in recent years, and it doesn't have a standardized definition the way that organic does. In essence, regenerative agriculture is a farming approach focused on restoring and enhancing soil health while also improving water quality, biodiversity, and overall ecosystem resilience. It aims to work in harmony with nature, rather than against it, to build a sustainable and productive food system.

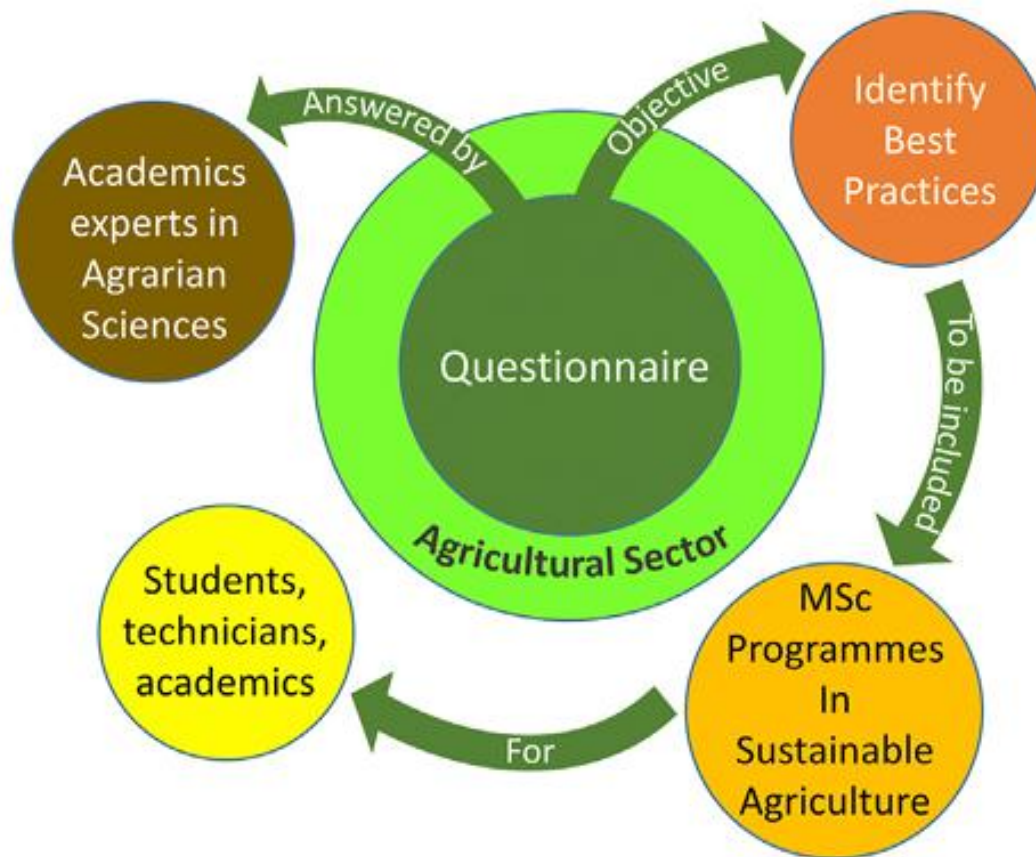
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In general, most of the agroecological practices remain at a low level of application in agriculture. Integration of organic fertilization, cover crops, drip irrigation, and biological pest control has already reached a medium level of integration in today's agriculture. The latter three, together with split fertilization and the use of plant-breeding cultivars, have, in our opinion, a high potential to be more broadly implemented in the next decade because they already benefit from good scientific knowledge as well as broad experience of farmers. Legislative regulations and laws in Europe or at the national level will probably boost the implementation of more environmentally friendly practices that are less polluting and less reliant on external inputs.



Graph 2.1. Agroecological practices with the potential to be integrated into today's agriculture

In the face of global environmental challenges, climate change, and the imperative need for more resilient and sustainable food systems, the role of agricultural education is undergoing a profound transformation. Vocational Education and Training (VET) teachers are at the forefront of this change, acting as the bridge between innovative agricultural practices and the future workforce.



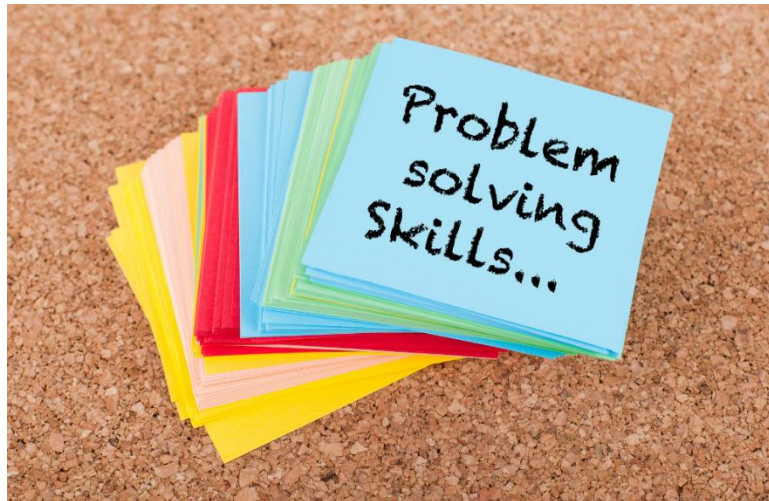
Scheme 2.4. Sustainable agriculture in the context of VET

Conclusion

VET plays a crucial role in agricultural education and training by equipping individuals with practical skills and knowledge needed for various agricultural roles. This includes training in areas like farm equipment maintenance, food processing, and building construction. ATVET (Agricultural Technical Vocational Education and Training) specifically focuses on developing skills in agriculture, promoting food security, and supporting rural development to effectively educate and inspire the next generation of farmers, agronomists, and food producers, VET teachers must be equipped with the skills, knowledge, and attitudes required to implement sustainable agriculture principles in school curricula and practice.

Furthermore, in an increasingly interconnected world, transnational collaboration plays a key role in sharing best practices, creating innovative educational resources, and fostering intercultural understanding.

Module 2. The Design Thinking and Problem Based Learning Methodology and its implementation in identification of problems and designing of solution.



I. The main aspects of Problem Based Learning as a method for increasing of STEM skills in students

1. Introduction to Problem-Based Learning

Problem-Based Learning (PBL) is a dynamic, student-centered pedagogical approach that places learners at the heart of the educational experience. Instead of passively receiving information from a teacher, students actively engage with authentic problems that require thoughtful analysis and innovative solutions. These problems are often based on real-world contexts, making learning relevant and meaningful. The goal of PBL is not only to acquire content knowledge but also to develop transferable skills such as critical thinking, communication, collaboration, and self-directed learning.

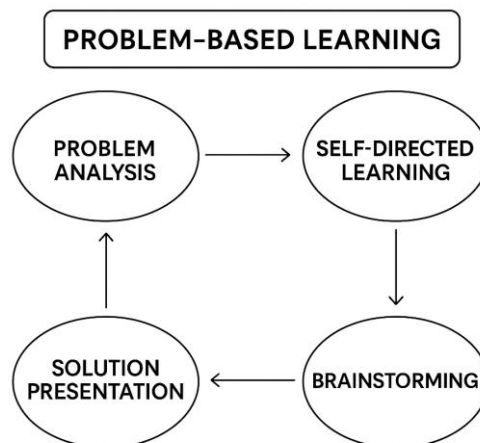
In a PBL environment, learning begins with a question or problem that lacks a clear, straightforward solution. Students work in small groups to explore the problem, determine what they already know, identify what they need to learn, and figure out how to access new information. This cycle of inquiry fosters deep learning and a sense of ownership over the educational process.

Teachers in a PBL classroom shift from being the primary source of information to becoming facilitators and guides. They support students in navigating their learning journeys by asking probing questions, providing feedback, and helping students reflect on their thought processes. This shift empowers students to take greater responsibility for their learning, preparing them for the complexities of life beyond the classroom.

By focusing on authentic, interdisciplinary problems, PBL not only enhances academic understanding but also prepares students for the collaborative and ever-changing nature of

Implementation of Design Thinking and Problem-Based Learning Methodology in designing and implementation of sustainable agricultural projects

the modern world. It cultivates curiosity, resilience, and a lifelong love of learning—qualities essential for success in the 21st century.



2. Core Principles of PBL

The foundation of Problem-Based Learning lies in several core principles that shape its structure and outcomes. These principles ensure that students are not only gaining knowledge but also developing essential life skills that will serve them beyond the classroom.

- Learning is driven by challenging, open-ended problems:

At the heart of PBL is the problem itself. These problems are typically complex, authentic, and lack a single correct answer. This pushes students to explore multiple perspectives, synthesize diverse information, and engage in creative problem-solving. The problem acts as a catalyst for inquiry and knowledge construction.

- Students work in collaborative groups:

Collaboration is a cornerstone of PBL. Students are grouped into teams where they must negotiate roles, share responsibilities, and leverage each other's strengths. Through group discussions, brainstorming, and shared decision-making, students enhance their communication and interpersonal skills while building a collective understanding of the topic.

- Teachers act as facilitators, not direct instructors: In a PBL setting, the role of the teacher shifts from delivering content to guiding learning. Facilitators support students by posing probing questions, helping clarify misunderstandings, and fostering metacognition. This approach encourages students to become more autonomous and reflective in their learning processes.
- Students direct their own learning, identify learning needs, and apply knowledge: PBL empowers students to take ownership of their learning. As they encounter gaps in their knowledge while attempting to solve the problem, they must independently or collaboratively research new concepts. This self-directed learning builds critical thinking and cultivates the ability to learn how to learn—an essential skill for lifelong success.

These core principles are interconnected and reinforce one another. By engaging with authentic problems, working collaboratively, being guided rather than instructed, and taking charge of their own learning, students develop a deeper understanding of content and improve their ability to apply knowledge in new and meaningful ways. Furthermore, these principles prepare students for real-world challenges by simulating the kinds of tasks and thought processes they will encounter in higher education, careers, and civic life.

3. Benefits of PBL in the Classroom

Implementing Problem-Based Learning in the classroom provides a wide range of educational benefits that extend beyond traditional academic achievement. It supports the development of essential 21st-century skills and creates a more engaging, student-centered learning environment. Below are four major benefits of PBL, each with significant implications for student growth and achievement.



- **Develops Critical Thinking and Problem-Solving Skills**

PBL challenges students to think critically about complex issues and to devise thoughtful, innovative solutions. In doing so, they must analyze information, evaluate evidence, synthesize diverse perspectives, and apply reasoning skills. These cognitive processes are vital for academic success and real-life decision-making. PBL encourages metacognitive reflection, helping students become more aware of their thought processes and improving their ability to tackle future problems effectively.

- **Promotes Teamwork and Communication:** Collaboration is a fundamental element of PBL. Working in groups, students practice essential social and interpersonal skills such as active listening, articulating ideas, giving and receiving constructive feedback, and resolving conflicts. These experiences mirror the collaborative dynamics of professional environments and help students build empathy, leadership, and adaptability. Strong communication skills developed in PBL are transferable across disciplines and crucial for both academic and career success.
- **Increases Student Engagement and Motivation:** Because PBL is based on real-world problems that are often relevant to students' lives, it naturally increases engagement. When students see the practical value of what they are learning, their intrinsic motivation to explore and understand grows. PBL allows for student choice and voice, offering learners the opportunity to direct their investigations and pursue solutions that matter to them. This autonomy fosters a deeper emotional connection to learning and often leads to improved academic persistence.
- **Bridges the Gap Between Theory and Practice:** Traditional instruction often separates abstract knowledge from its application, leaving students unsure how academic learning connects to real life. PBL closes this gap by immersing students in realistic scenarios that demand the use of academic concepts and skills. Whether through building a prototype, conducting interviews, analyzing data, or proposing

policy changes, students apply their learning in meaningful ways. This hands-on, experiential learning deepens understanding and makes content more memorable.

In summary, the benefits of PBL go far beyond the mastery of content. It cultivates the critical competencies students need to thrive in a rapidly changing, interconnected world. Through PBL, learners become more engaged, skilled, and confident individuals who are better prepared to solve the complex problems of the future.

4. Roles and Responsibilities

In a PBL environment, the success of the learning experience depends on clearly defined roles and shared responsibilities among all participants. Effective implementation of PBL requires students, teachers, and groups to understand and embrace their distinct functions within the learning process. These roles foster a collaborative and inquiry-driven atmosphere that is essential for meaningful learning.

- **Teacher: Facilitator, Guide, Coach**

The teacher plays a crucial yet transformed role in a PBL classroom. Rather than serving as the primary source of information, the teacher acts as a facilitator who provides structure and support while encouraging student autonomy. Teachers guide inquiry, pose thought-provoking questions, model research and reflection strategies, and help students stay focused on the problem at hand. They also help students navigate group dynamics and support the development of self-directed learning skills. As coaches, teachers observe and provide feedback on both the process and the outcomes of learning, empowering students to grow in both confidence and competence.

- **Student: Active Learner, Collaborator, Investigator**

Students take on a proactive role in their learning journey. They are responsible for engaging deeply with the problem, participating in group discussions, conducting independent and group research, and reflecting on their learning. Students must be willing to question assumptions, explore new ideas, and adapt their thinking based on evidence. As collaborators, they contribute to group efforts, respect differing viewpoints, and support each other's growth. As investigators, they take initiative to pursue learning goals, seek out credible resources, and apply their knowledge in meaningful contexts.

- **Group: Self-Managing Unit Responsible for Solving the Problem**

Each student group operates as an autonomous learning team with a shared objective—to solve the problem presented. Groups are expected to manage their time, distribute tasks equitably, and make collective decisions. Successful group work depends on mutual accountability, effective communication, and ongoing reflection. Groups are not only responsible for reaching a solution but also for documenting their process, presenting their findings, and evaluating their collaboration. These group dynamics mirror real-world professional and academic settings, preparing students to work effectively in diverse teams.

Clearly defined and mutually respected roles help create a classroom culture where learning is a shared responsibility. When students, teachers, and groups understand and fulfill their responsibilities, the PBL experience becomes more productive, empowering, and transformative.

5. Designing Effective PBL Activities

Creating impactful PBL experiences involves more than just selecting an interesting problem—it requires thoughtful planning, alignment with learning objectives, and attention to student needs. Effective PBL design includes the following elements:

- **Real-World Relevance:** Choose problems that are authentic and meaningful to students. Real-world issues encourage deeper engagement and make learning more relatable.
- **Curriculum Alignment:** Ensure that the problem and the learning process align with academic standards and intended learning outcomes across subject areas.
- **Structured Learning:** While students take the lead in inquiry, they benefit from a structured learning pathway. Provide clear expectations, timelines, checkpoints, and support materials.
- **Open-Ended Questions:** Frame the problem in a way that allows multiple solutions and promotes critical thinking. Avoid problems with simple or binary answers.
- **Interdisciplinary Potential:** Design problems that encourage integration of knowledge and skills from multiple disciplines—this mirrors real-life complexity and encourages holistic learning.
- **Student Voice and Choice:** Allow students to make decisions about how they approach the problem, how they organize their work, and how they present their findings. Choice fosters ownership and motivation.
- **Opportunities for Reflection and Feedback:** Include moments for individual and group reflection throughout the process. Provide feedback loops to support student growth and refine learning strategies.

By attending to these components during the planning phase, educators can design PBL experiences that are academically rigorous, deeply engaging, and transformative for students.



6. Facilitating the PBL Process

Facilitation is a key component of the Problem-Based Learning process. Unlike traditional instruction where the teacher leads and students follow, PBL places the teacher in the role of a facilitator—one who creates the conditions for active, student-driven learning. Successful facilitation requires balancing guidance

with autonomy and supporting learners as they navigate the complexities of problem-solving.

- **Creating a Supportive Learning Environment:** A positive and safe classroom culture is essential for effective PBL. Facilitators should foster an environment of respect, curiosity, and open communication. Students must feel comfortable taking risks, sharing ideas, and learning from mistakes.
- **Introducing the Problem:** The initial presentation of the problem sets the tone for the entire learning experience. Facilitators should introduce the problem in a way that is engaging and thought-provoking. It should be complex enough to stimulate inquiry and open enough to allow multiple perspectives and approaches.
- **Guiding Inquiry:** While students direct their learning, facilitators provide scaffolding to help them stay focused and productive. This may involve asking open-ended questions, redirecting unproductive paths, or suggesting resources. The goal is to deepen student thinking without giving away answers.
- **Monitoring Group Dynamics:** Group work is central to PBL, and effective facilitation includes observing and supporting group collaboration. Teachers should encourage inclusive participation, mediate conflicts, and coach students on effective communication and time management strategies.
- **Encouraging self-reflection:** Facilitators should prompt students to reflect on what they are learning and how they are learning it. Regular check-ins, reflection prompts, and group discussions can help students become more aware of their cognitive processes and refine their approaches to problem-solving.
- **Providing Feedback and Encouragement:** Timely, constructive feedback is crucial in PBL. Facilitators should provide formative feedback throughout the process, focusing on both content understanding and skill development. Encouragement and positive reinforcement can boost student confidence and motivation.
- **Balancing Intervention and Independence:** Perhaps the most challenging aspect of facilitation is knowing when to step in and when to step back. Facilitators must resist the urge to take over and instead trust the process, allowing students to struggle productively and discover solutions on their own.
- **Celebrating Progress and Success:** Recognizing student effort and progress helps maintain momentum. Facilitators should celebrate milestones, highlight successful strategies, and encourage peer recognition to build a sense of accomplishment and community.

Effective facilitation transforms the teacher-student dynamic and elevates the learning experience. By guiding without controlling, questioning without judging, and supporting without enabling, facilitators empower students to take charge of their learning and become thoughtful, independent problem-solvers.

7. Assessment in PBL

Assessment in Problem-Based Learning requires a shift from traditional grading practices toward a more holistic and formative approach. Since PBL emphasizes not only content

mastery but also the development of critical thinking, collaboration, and problem-solving skills, assessment strategies must align with these broader learning outcomes.

- **Formative Assessment:** Ongoing assessment throughout the PBL process provides valuable feedback to both students and teachers. This includes observations, peer and self-assessments, learning journals, group discussions, and progress check-ins. Formative assessment helps students monitor their growth, reflect on their learning, and make adjustments as needed.
- **Performance-Based Tasks:** Rather than relying solely on tests or quizzes, PBL assessment focuses on the demonstration of learning through products and presentations. Students may be evaluated on research reports, multimedia projects, physical models, simulations, or formal presentations. These deliverables should reflect both the process and the content of learning.
- **Self and Peer Assessment:** PBL encourages students to take ownership of their learning. Self-assessment fosters reflection, while peer assessment promotes accountability and constructive feedback. These practices also help build students' evaluative and interpersonal skills.
- **Group and Individual Contributions:** Assessment should consider both group achievements and individual efforts. While the group may produce a collective outcome, individual accountability can be assessed through logs, journals, participation records, and reflection essays.
- **Reflection as Assessment:** Reflection is a powerful assessment tool in PBL. Asking students to articulate what they learned, how they approached the problem, and how they collaborated allows teachers to evaluate deeper learning and skill development. Reflection also supports students in identifying areas for future growth.
- **Alignment with Learning Goals:** All assessment methods should align with the learning goals and desired outcomes of the PBL unit. Teachers should ensure that assessment captures not only what students learned but how they learned it and how they can apply it in new contexts.

Through comprehensive and multi-dimensional assessment strategies, educators can capture the richness of student learning in PBL. Thoughtful assessment validates the process, guides improvement, and honors the depth and breadth of skills that students develop through problem-based experiences.

8. Managing Challenges in PBL

While Problem-Based Learning offers numerous benefits, it also presents a unique set of challenges for both teachers and students. Being proactive in recognizing and addressing these challenges is key to successful implementation. Below are common obstacles and practical strategies for managing them:

- **Time Management:** PBL can be time-consuming due to its open-ended and exploratory nature. Teachers may struggle to cover all required content within traditional timeframes. To address this, plan carefully by setting clear milestones and

deadlines. Integrate PBL with curriculum standards and consider using a project calendar or timeline visible to students.

- **Student Readiness:** Not all students are initially prepared for the autonomy and responsibility that PBL requires. To build readiness, scaffold the development of skills such as research, collaboration, and self-regulation. Provide explicit instruction in these areas early in the year and gradually release responsibility.
- **Assessment Difficulties:** Evaluating group work, individual contributions, and open-ended projects can be complex. Use a variety of assessment tools—rubrics, checklists, reflections, and peer assessments—to capture a comprehensive picture of student learning. Be transparent about expectations and allow for ongoing feedback.
- **Group Dynamics and Conflicts:** Collaboration doesn't always go smoothly. Conflicts can arise due to differing work ethics, communication styles, or roles. Teach students about team roles, conflict resolution strategies, and productive communication. Periodically check in with groups and mediate when necessary.
- **Access to Resources:** PBL often requires diverse materials and access to technology, community contacts, or research tools. If resources are limited, encourage students to be creative with what is available. Build partnerships with local organizations, use open-source materials, or adapt projects to fit your context.
- **Teacher Role Transition:** Teachers used to direct instruction may find it challenging to shift to a facilitator role. Professional development, collaboration with peers, and reflective practice can support this transition. Start with smaller PBL units to build confidence before scaling up.
- **Maintaining Student Motivation:** Students may lose focus or become frustrated during long-term projects. Keep them engaged by incorporating choice, offering checkpoints for success, and celebrating progress. Authentic audiences and real-world impact can also enhance motivation.

By anticipating these challenges and applying thoughtful strategies, teachers can create a more resilient and supportive PBL environment. With time and practice, these challenges become opportunities for professional growth and deeper student learning.

9. Integrating PBL Across the Curriculum

One of the strengths of Problem-Based Learning is its versatility and adaptability across different subject areas. When integrated effectively, PBL can enhance interdisciplinary connections and deepen student understanding by showing how knowledge and skills from various disciplines intersect in real-world problems.

- **Identify Common Themes and Problems:** Look for overarching themes or community issues that can be explored through multiple lenses. For example, a unit on climate change can involve science (environmental science, biology), social studies, economics, languages (persuasive writing, communication), and math (data analysis, statistics).

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- **Collaborative Planning Among Teachers:** Encourage collaboration among teachers from different subjects to design cohesive PBL units. Joint planning sessions can help align learning objectives and assessments, ensuring that each discipline contributes meaningfully to the problem exploration.
- **Flexible Scheduling:** Schools may need to adopt block scheduling or flexible time blocks to allow extended periods for in-depth inquiry, discussion, and project work that PBL demands.
- **Use Real-World Problems That Require Multiple Disciplines:** Select problems that naturally require interdisciplinary knowledge. For instance, designing a sustainable city involves urban planning (social studies), engineering principles (science), budgeting and economics (math), and community engagement (languages).
- **Encourage Student Reflection on Disciplinary Connections:** Guide students to explicitly identify how different subject areas inform their problem-solving process, helping them to see the relevance and application of diverse knowledge.
- **Integrate Technology and Resources Across Subjects:** Use digital tools that support multiple disciplines, such as design software, collaborative platforms, research databases.
- **Celebrate Interdisciplinary Outcomes:** Showcase student projects that highlight interdisciplinary approaches, fostering pride in holistic learning and encouraging further collaboration.

By thoughtfully integrating PBL across the curriculum, schools can create a rich, cohesive learning experience that mirrors the complexity of real-world challenges, better preparing students for future academic and career endeavors.

10. Using Technology to Support PBL

Technology can be a powerful ally in Problem-Based Learning, enhancing collaboration, research, creativity, and presentation. Integrating appropriate digital tools helps students manage complex projects and deepen their learning experience.

- **Facilitating Collaboration:** Tools like Google Workspace (Docs, Slides, Sheets), Microsoft Teams, and collaborative whiteboards (Jamboard, Miro) enable students to work together in real-time, whether in-person or remotely. These platforms support brainstorming, document sharing, and group organization.
- **Research and Information Gathering:** The internet offers vast resources for inquiry. Teaching students how to evaluate credible sources and use digital libraries, databases, and educational websites fosters effective research skills critical for PBL.
- **Data Collection and Analysis:** Tools such as spreadsheets, graphing software, and simulation programs help students organize, visualize, and interpret data, supporting evidence-based conclusions.

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- **Creative Expression and Presentation:** Multimedia tools (Canva, Powtoon, Adobe Spark) allow students to create engaging presentations, videos, infographics, and digital stories that communicate their solutions effectively.
- **Project Management:** Apps like Trello or Asana can help groups plan, assign tasks, and track progress, teaching students valuable organizational and time-management skills.
- **Communication:** Platforms such as Zoom or Google Meet facilitate virtual meetings with peers, experts, or community members, expanding learning opportunities beyond the classroom.
- **Accessibility and Differentiation:** Technology provides diverse ways for students to access information and demonstrate understanding, supporting varied learning styles and needs.



Successful integration requires teacher guidance to ensure purposeful use of technology that enhances rather than distracts from learning goals. Providing training and support helps both teachers and students leverage these tools effectively.

11. Reflection and Continuous Improvement

Reflection is a vital component of Problem-Based Learning, fostering deeper understanding and ongoing growth for both students and educators. Continuous improvement ensures that the PBL experience evolves to better meet learners' needs and enhances teaching practices over time.

- **Student Reflection:**
Encourage students to regularly reflect on their learning journey. This includes evaluating what they have learned, how they approached problem-solving, the effectiveness of their collaboration, and challenges they faced. Reflection can take many forms, such as learning journals, group discussions, self-assessment checklists, or digital portfolios. By making reflection routine, students develop metacognitive skills that help them become more self-aware, adaptable, and responsible learners.
- **Teacher Reflection:**
Teachers should also engage in regular reflection on their facilitation of PBL. This involves analyzing what strategies were effective, what obstacles emerged, and how students responded to different aspects of the process. Reflective practices may include journaling, peer observations, student feedback, and professional learning communities. Reflection supports continuous refinement of instructional design, classroom management, and assessment practices.
- **Feedback Loops:**
Establishing clear channels for ongoing feedback between students and teachers enhances continuous improvement. Feedback should be constructive, specific, and timely. Peer feedback fosters a collaborative learning culture, while teacher feedback

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guides students' progress and motivation. Reflection combined with feedback encourages a growth mindset and resilience.

- **Iterative Project Development:**
PBL naturally supports iterative learning, where students revisit and revise their ideas and products based on reflection and feedback. Encourage cycles of prototyping, testing, and improving solutions. This process mirrors real-world problem-solving and helps students understand that learning is a dynamic, evolving process.
- **Professional Development:**
Continuous improvement for educators involves seeking out professional development opportunities focused on PBL methodologies, classroom technology, and assessment strategies. Participating in workshops, webinars, or collaborative planning with colleagues keeps teachers updated on best practices and innovative approaches.
- **Data-Informed Decisions:**
Use data from assessments, reflections, and student outcomes to inform instructional adjustments. Tracking progress over multiple PBL cycles helps identify patterns, strengths, and areas needing support. This evidence-based approach promotes intentional refinement of curriculum and teaching methods.
- **Cultivating a Reflective Culture:**
Foster a classroom environment where reflection and improvement are valued and normalized. Modeling reflective practice and encouraging open dialogue about successes and setbacks create a safe space for risk-taking and learning from mistakes.

By embedding reflection and continuous improvement into the PBL framework, educators and students alike engage in lifelong learning. This ongoing process enriches the educational experience, promotes deeper mastery, and equips learners with skills essential for adapting to the complexities of the modern world.

II. The concept of Design Thinking Methodology and its implementation in identification of problems and designing of solution



Introduction

Design Thinking is a student-centered, problem-solving methodology that empowers learners to develop empathy, think creatively, and apply critical thinking skills in solving real-world challenges. As an educator, your role is to guide students through a structured yet flexible process that encourages inquiry, exploration, and innovation.

Design Thinking typically follows five key phases: Empathize, Define, Ideate, Prototype, and Test. These phases are not strictly linear—students may cycle back and forth as they refine their understanding and improve their solutions. The goal is not only to find answers, but to foster a mindset of curiosity, resilience, and user-focused design.

Why Use Design Thinking in the Classroom?

Design Thinking enhances students' ability to identify authentic problems by engaging with the perspectives and needs of real users or communities. Through interviews, observations, and empathy-building exercises, students learn to look beyond obvious issues and uncover root causes. This deep understanding forms the basis for framing meaningful problem statements that inspire solution-oriented thinking.

Once the problem is well-defined, students are guided to generate and test creative solutions. The classroom becomes a collaborative innovation space where brainstorming, prototyping, and peer feedback are core activities. By testing ideas early and often, students learn from failure, adapt their thinking, and strengthen their designs based on evidence and reflection.

Teacher's Role in Implementation

As a facilitator, your task is to:

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- Create a supportive and open environment where students feel safe to experiment and take risks.
- Scaffold each phase with tools, prompts, and guiding questions.
- Encourage teamwork and inclusive dialogue.
- Help students reflect on both process and product.

Design Thinking is not limited to any one subject—it can be embedded across the curriculum and adapted to suit various age groups and learning objectives. Whether applied to social issues, environmental challenges, or everyday problems, this methodology equips students with 21st-century skills that are essential for lifelong learning and active citizenship.

PHASE 1. UNDERSTANDING

The goal of the first stage, "Understanding", is the correct definition and understanding of a certain problem, the reasons that led to it, as well as the consequences of its existence.



At the very beginning, each of the teams should identify a specific problem for which they should offer an appropriate solution. Explain to the teams that a thorough understanding of the problem, its causes, as well as the consequences of its existence, is the key to helping us build successful solutions.

Assess how well the teams have understood the problem they have to solve and ask questions like: "What do you think – what does that mean?" and/or "Give me an example?".

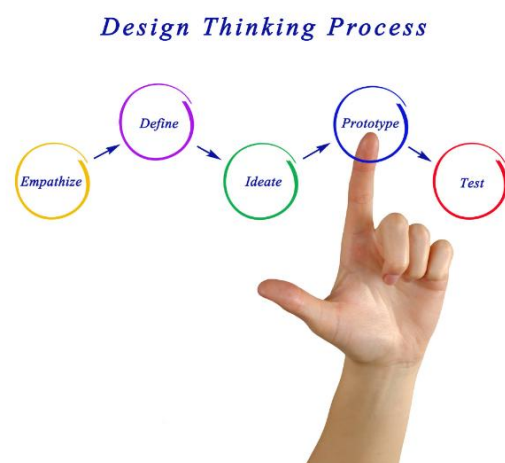
1.1. PROBLEM TREE AND THE FIVE "WHYs?"

Explain that there are simple tools and techniques that can be used to gain a full understanding of the cause of the problem and its consequences.

Introduce the "Problem Tree" technique and ask each team to draw a tree on a flipchart sheet.

Encourage each team to formulate the problem more specifically and then write it on the "trunk" of the tree.

Explain that each team's first task is to think about the consequences of the problem they have identified. It is best that initially you give an example of a problem the students are facing and discuss the consequences of its existence. For example, take the problem of poor/inappropriate further education/career choices that students often make. Discuss with the students what the consequences of this might be: dissatisfied/unmotivated students,



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incomplete education, increased youth unemployment, dissatisfied parents, economic consequences, etc. Each team should write down each consequence of the problem on a piece of paper and stick it on the drawing, like a tree branch. Encourage each team to identify as many consequences of the problem's existence as possible.

The next task is to identify the causes of the problem. Ask all teams to choose one cause and explain the relationship between the cause and the problem. For example, in the problem of poor choice of further education of young people, one reason is the influence of parents in the choice and their opinion that they know best where their child should continue his education. Help the team think about the reasons that led to their problem. Each reason should be written on a piece of paper and placed on top of the "roots" of the tree. Let every cause be one root.

Explain to the teams that the process of creating the "Problem Tree" is iterative, that is, they can always go back and add new causes or effects, or remove them, as the understanding of the problem progresses.

The next step is to assess the causes and see where it is necessary to intervene in order to reach a possible solution to the problem.

Explain that there is a technique called the "Five Whys" which, although very simple, is often used by some of the best companies in the private sector to get to the root causes of a problem. The technique helps to identify the causes of even complex problems and to assess where to intervene in the chain of causes.

Choose one root/cause and formulate a "Why?" question. For example: For parents who decide/influence what kind of education their child should continue "Why do parents decide/influence the future education of their children?"; The answer may be that parents do not have enough information about the factors that should be taken into account when choosing a future education. And to the question "Why don't they have information?" teams may respond that there is a general lack of information on the topic, and/or that parents do not have access to existing information, and/or do not accept the information they receive because they are pressured by economic problems, social norms, etc. The answers should be written on sticky notes, one under the other, at the very root where the reason is placed.

Ask the teams to apply the same technique to the other causes they have identified. Encourage teams to ask the "Why" questions five times. They won't always be able to ask the "Why" questions five times. When they can't go any further, don't pressure them if they think they've established the real/root cause.

Ask the team to review the results obtained, to think about which reasons they think are the most important and why.

1.2. TARGET GROUPS AND PARTIES/STAKEHOLDERS INVOLVED

Even before starting the implementation of the project, give the students/teams the task to find groups of involved parties/stakeholders and defining their relationship to the problem they have identified.

Emphasize the importance of determining exactly who is contributing to the problem and who is in some way, directly or indirectly, related to that problem. This is very important so that we

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can identify our partners and create solutions that will overcome the problem or address how they contribute to the existence of the problem.

Ask the team to distinguish between the target group (those directly affected by the problem) and other involved parties/stakeholders.

Explain that the process is repeatable and that you can always come back and confirm or change things.

Ask the teams to define their target groups/direct beneficiaries, indirect beneficiaries and stakeholders according to relevant characteristics (could be by age, gender, location, ethnicity, language, economic status, job title/function, etc.). You will likely need to support the teams in selecting relevant features. Use sticky notes to add stakeholder features to the map.

Ask questions to highlight where and when definitions may be inaccurate, irrelevant, misleading or even stereotypical (eg: if one characteristic applies to a particular case, it may not be relevant in all or most cases).

Explain to the teams that the development process is iterative; they can always go back and add new causes or effects, or even remove them, as their understanding of the actors progresses.

It is necessary for each team to give an overview of all involved parties/stakeholders and their characteristics.

Ask the teams to review the results and think about the characteristics of their target group. Ask them if they can imagine a person that results from the characteristics they have developed. Also ask them to consider whether they think some of the stakeholders are more important/or more closely related to the problem than others.

1.3. PERSONAS

Ask participants to think about their own personal experiences, to what they and other people react more: to a news article about a situation affecting thousands of people, in which there are no names, pictures or personal stories, or to a news article about a named person, where their picture is published and their personal story is told.

Explain that it is much easier to relate to, understand, and develop a solution for one specific, defined person than for a larger, vague group.

Explain that professionals in the fields of advertising and software design agree that it is easier to work with one person than with a group and have developed a method that helps us do just that. That method is called "Personas".

Explain that a persona is a fictitious "character" we create to represent a group of stakeholders, and we attribute to that person the characteristics, needs, and behaviors of that group. We use personas when we design our solution to fit the needs and requirements of stakeholder groups. Personas become the "people" for whom we create a solution.



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Review the personality template with team members.

Ask the teams to look at the map of involved parties/stakeholders and determine which ones will be prioritized in their solutions. The target group should be one of them!

Start with your target group and review the criteria that define that group.

Using the personality template, imagine a fictitious character that will correspond to the target group. Start with demographics.

Eg: Is your target group girls? Make that character a girl. Is she between the ages of 14 and 22? Make her 18 years old. Are the girls schoolgirls? Make her a student at the local school. Where does she live? Does she have any siblings? The goal is to make the person as realistic as possible. Give your persona a name.

Ask the teams to consider what stakeholders from that group have to say in terms of their experience and connection to the problem and how it affects them (and specific consequences for them), their motivation, goals and frustrations/pains.

Ask the teams to synthesize the findings and add them to their personas.

Ask the teams to think of a quote about something their person would say to outline their position on the issue.

For example, regarding the choice of future education, Maria from Kumanovo says: "I know that my parents really want me to enroll in the medical faculty and be a doctor, but I cannot convince them that medicine is not of interest to me and that I will never finish that faculty!"

In the end, you need to get the persona for the target group.

Ask the teams to create one or two additional personas for other key stakeholders.

Ask questions to get an overview of what the persona's purpose is.

Place your personas and map of involved parties/stakeholders in a visible and accessible place.

1.4. END-STATE AND IMPACT STATEMENT

Ask the students to think of times when they had to set a big goal – you could use the example "I'm going to graduate in medicine and become a successful doctor with my own practice." Ask them if when they set that goal, did they know every step they needed to take to reach the goal? The answer will be, probably, no, but that doesn't stop them from making a vision of where they will end up and what their life will look like when they reach that goal.

Explain that setting a goal and a vision of what life will look like after achieving the goal is a useful tool for identifying the steps that must be taken to achieve the goal.

In the example with the doctor, there is an explicitly stated step that is taken in advance: "I will finish medical faculty. This implies a previous step: "I will pass all the exams" and before that another step "I will enroll in the medical faculty"! It is also in our vision that he will have his

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own practice, and this implies additional steps such as "I will know how to start and run a successful business," and before that, "I will also learn the principles of running a business"!

Explain that the "End State" forecast (sometimes called a "vision statement") is a very useful tool. The end state is the goal of our project and answers the question "What will things look like for the target group when the problem is solved?" The entire project is developed backwards from the end state to ensure that all project activities, product features and/or service are aligned with that goal. Just like when we set a goal to become a doctor and it involves taking steps backwards from our ultimate goal.

Encourage the students to put themselves in the position of the target person.

Ask them to state the problem as it is now.

Following the directions from the think-loud, ask students to consider the problem and the person.

Ask the students to describe the situation after the problem is solved. How will the lives of the members of the target group be different? What conditions have changed? What can he/she do, know, believe or understand that was not the case before?

Help the team to concisely formulate an "end state" that captures the most meaningful and relevant elements.

Ask the students to think about the "End State" from their personal perspective (i.e. from the perspective of the team tasked with bringing the target group to the end state).

Explain that the "impact" of our product or service is the change we want to achieve in the long term for the well-being of the target group. Explain that the "Impact Statement" describes what the product or service will achieve and what will contribute to the end state.

Go back to the doctor's example. In this case, a product or service that will help one become a doctor is likely one that will help one get into and/or complete medical faculty – such as additional education/courses, an internship program, etc.

An impact statement describes the contribution of our product or service. In the physician example, an impact statement might be "improved learning and increased enrollment of students graduating from medical faculty."

Point out that the achievement of the end state and impacts will not be 100% under the project's control (eg: many factors influence whether a person becomes a doctor or not!), but the project will contribute to that goal by influencing one (or several) of the causes of the problem.

Ask the teams to revisit the "problem tree" to identify which causes of the problem are more relevant to achieving the end state. Ask them to think about which reason or reasons are the biggest obstacles to achieving the end state.

In doing so, emphasize that they should not yet think about the final product or service they will make, but about what should be achieved with that product or service.

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Ask the teams to formulate an impact statement describing the effects of their solutions to the problem that will help achieve the end state. Remind them that we don't yet know what the solution will be, but we understand the problem well enough to identify what can be accomplished.

Note: This process can be quite challenging. Your goal as a teacher is to help teams move from the focus on the activity or features, to the impact to be achieved. It's key to getting teams to think back from the goal and start focusing on the element of the problem they want to work on. Be prepared to provide guidance so that they can choose something that has more impact but is still within their capacity to do so.

Ask the teams to discuss and formulate the impact statement.

Together with the teams, review the relationship between the problem, the person, the end state and the impact statement.

You might adopt the following wording to communicate such a relationship: "[Person] is currently facing a [problem]. To address [problem], our solution will [impact] such that [person] will [end state]."



PHASE 2: DESIGN

After defining the problem tree, personas, end-state and impact statement, as well as the user research and stakeholder mapping phase, the teams should already have identified the problem and understood the experiences of those affected and related to the problem. The next step is to approach the design of an appropriate solution.

2.1. A DESIGN CHALLENGE

The "Design Challenge" is a tool that helps consolidate learning and move from understanding a problem to creating a solution.

Ask the teams to revisit the "problem tree" and the end-state and impacts statement.

Try rephrasing the impact statement as a question:

Eg: if the impact statement is "Parents have access to information about factors to consider when choosing future education", we can formulate the design challenge as "How can we give

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parents the information they need to feel more confident and allow their children to choose their own future education/career?"

Ask the teams:

Is my question aligned with the impacts they hope to achieve?

Does the question allow for a range of different solutions?

Does my question take into account the constraints and the context?

Help the teams reframe "How can we" questions by considering impacts, different solutions, constraints, and context.

Continue until the question is neither very detailed nor very general and meets the three criteria listed above.

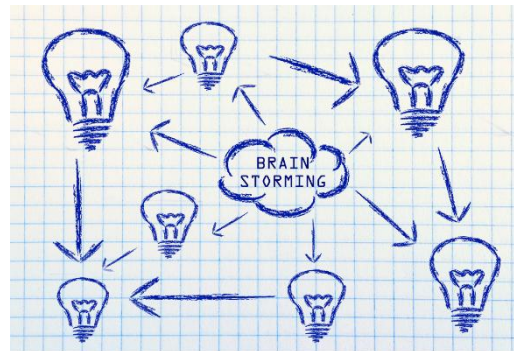
When the team feels ready, have them write up their Design Challenge and hang it up somewhere they can see it often.

Take time to praise and encourage teams and highlight their specific successes and strengths.

2.2. BRAINSTORMING

Ask the teams to reflect on the first phase and explain that some exercises, such as the problem tree and stakeholder map, helped us get as many ideas and information as possible, while other exercises, such as user research and the "5 WHYS?" helped us research and build on that information to catalyze new and improved versions.

Some exercises, such as "Personas" and "Design Challenge", helped us to filter ideas and information and to concretize and focus our efforts.



This cycle of exercises of getting more ideas and information, exploring and improving the ideas, then focusing on the best ideas and moving on is a basic feature of a design process.

The first cycle focused on understanding and defining the problem and the context, and the next cycle focused on imagining, building and selecting promising solutions.

Ask students to relate it to their own experiences, to recall times when they had to find a solution to a problem. Is the solution always obvious? Most of the time, they had to think about several possible solutions, research and develop a few that are most suitable and choose the best ones, improve them and apply them.

Explain that brainstorming is a process through which teams generate ideas to solve their problem. Emphasize that the goal is not to create a complete or perfect solution, but the emphasis should be on generating as many ideas as possible.

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Finally, point out that later in the process there will be steps to filter out ideas that don't work. However, at this stage, teams should concentrate on creativity!

Introduce the basic principles of brainstorming:

- a. Don't judge. You never know where a good idea might come from. The key is that everyone feels they can say the idea they have in mind and allow others to add to it.
- b. Encourage quirky ideas. Strange ideas can often lead to creative leaps. When we think of ideas that are outlandish, we tend to think of what we really want without any limitations in terms of technology or materials.
- c. Go for quantity. Aim for as many new ideas as possible. Brainstorm ideas quickly and go with the best ones.
- d. Write everything down! Everything that comes to your mind, write it down. One idea per sticky note.

Hand out sticky notes and set a time of 5 minutes on the clock. Tell the team members that they will work independently first, so that there is no judgment and more ideas can be gathered, but that after 5 minutes they will come together to share the ideas together. They write only one idea on each sticky note.

Again, encourage the teams to aim for speed and quantity, and to propose bold solutions. Perhaps the team members will show reluctance to "do it"; try to suggest one or two "crazy" ideas to show them that they can go further in their thinking.

After the five minutes are up, ask the team members to place the sticky notes on the wall or table. Encourage them to look at the ideas. Get them to move the slips and group similar ideas. Discuss the ideas.

Encourage the team members to complement each other's ideas. Being positive and building on the ideas of others takes skill. In conversations, we tend to use "and" instead of "but."

Only one team member speaks at a time. Each team is more likely to build on an idea and make a creative breakthrough if everyone listens carefully when a new idea is shared.

An idea is nobody's property — once an idea is on the board/table, it belongs to everyone!

Note: Try praising and encouraging quirky ideas to boost the team's confidence in their creativity. You can frame the discussion by thinking aloud as you identify and complement promising ideas and ask questions about unclear ideas.

Ask the teams to filter and eliminate ideas that don't meet user needs or are unfeasible. Remind them to remove only those things that absolutely do not fit.

Have each team come up with a few sets of ideas that the team feels comfortable with.

Ask the teams how they feel at the end of this process. Full of energy? Confused? Can they see the solutions? Did they enjoy it?



Re-emphasize the purpose of brainstorming: to generate as many creative ideas as possible because that way we get lots of ideas to work on. You can use the analogy of a toolbox. A toolbox containing only a hammer and screwdriver limits you in the ways you can fix something; brainstorming adds many tools of different types, gives us options and allows us to create better solutions.

Have each team keep the brainstorming results in a visible place.

2.3. MODEL/CONCEPT DEVELOPMENT

Ask the teams to reflect on the ideas they have generated. Point out that at this stage they may see solutions beginning to emerge, but that those solutions are incomplete. They may see ways in which the ideas are connected to each other as part of a larger product or service, but at this stage, those connections are not clear.

Explain that prototype/concept development is a creative process where ideas are built upon and connected into a complete product or service. We will use sketching to show the connection between ideas and to visualize what users will actually do.

The concept should provide a solution to your "Design Challenge", complement and connect your ideas and reflect the context of your personality.

The teams should not use all of the ideas from the brainstorming, but only those that they feel should be part of the solution. They can also add ideas later in the process.

Create a visualization. That is crucial. Sketches should be composed of words and pictures. It doesn't matter if your drawing skills are weak. It is recommended to use line drawings so as not to waste time drawing.

Sketches should represent a map of how users use the product or service. Their personas should be represented in the model!

Explain to the team members that they have ten minutes to independently sketch their model and then together they will discuss, do another round of individual sketches, discuss again and finally produce a final model together. Again, the model should draw on the ideas identified during brainstorming and organize them into a logical flow.

Note: At this stage, it is important to ask questions to help them advance their models and highlight gaps. Questions like "How did users first find out about your product or service?" "Where is that service provided or who provides the service?" are great to start with. Questions that highlight the disconnect between the concept and the personas may also help: e.g., "How will (the person) be motivated?", "How will your concept reflect a particular state of your person (eg: your person does not go to school, or has limited access to the internet)?"

Give praise and encouragement for how team members complement each other's ideas. At this stage, tension can arise within the team, as decisions will be made about which elements should be included and which should be removed. It is understandable if there is some tension; it is up to you as the teacher to determine if this is acceptable and what it is that requires your intervention. If you must intervene, emphasize that everyone has a right to speak and that everyone has a right to be heard.

Ask the teams how they feel at the end of this process. Full of energy? Confused? Do they see solutions starting to be created? Did they enjoy it?

PHASE 3. DEVELOPMENT AND TESTING

Once the team has developed a solution, the next step is to build a version of the solution to be tested! Prototyping is when we start getting ideas off paper and building testable versions of parts of our product or service. Prototypes help us move to a "Minimum Viable Product" — a version of the final product that does the key things but lacks additional attractive features.

3.1. PROTOTYPE MAKING

Explain the purpose of prototyping: to create a basic version of key elements of a product or service that we can test and learn from. Highlight the following:

- The prototype does not have to be perfect. Don't waste time on colors, special text, etc.
- Prototyping is an iterative process: we create something, test it, learn from it, then remove the unnecessary and build a better version!

There are a variety of ways to make prototypes, but we'll stick to four:

1. **Role playing** (recommended when we have *interaction*)
2. **Illustrated sketch** (recommended when we have *services*)
3. **Paper prototypes** (recommended when we have *digital tools*)
4. **Physical models** (recommended when we have concrete *physical products*).

3.1.1. SELECTION OF PROTOTYPE FOR PRODUCTION

Explain that the first step is to decide what to prototype.

Ask the teams to divide one flipchart sheet into four squares and label the squares with: Interactions, Services, Digital Tools/Information and Physical Products.

Interaction: Should we represent where and how users interact in our model? It can be when selling a product, when we train someone, etc.

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Services: Where do we deliver the service? The service could be holding a training session, hosting a sporting event, providing legal assistance or handing out food as a relief.

Digital tools/information: Where do we use digital tools or give information to/get information from people using media? It can be creating a website, using a form or transmitting certain information.

Physical products: Where do we use or make a physical product? It can be, for example, building a children's playground, making a device or solar-powered lamps.

Note: Almost every model will have more than one of these elements; some model components will contain all four! Ask the team to prepare a list of items in each of the four categories that they need to prototype by writing each component on a separate sticky note and placing the note in the appropriate place in a designated square.

Each team has to decide which component to prototype. The focus should be on the components that are critical to the product or service solution.

If the entire solution is about holding training, for example, concentrate on the elements that relate to training. It is also good to prioritize the user-facing elements, that is, the elements that the target group will use or interact with.

Teams will likely not be able to prototype all elements in the limited time; prioritize the key things. It is enough to make a prototype of one or two elements. Review with the team the components they have chosen to build a prototype. Ask them to think about why they prioritized that component. Praise and validate their decision.

3.1.2. METHODS AND FABRICATION

Go back to the components of the product or service that the team decided to prototype. Explain that, as previously shared, there are many different techniques or methods designers use to prototype a solution, but some methods fit certain "categories" more than others. For example, it's hard to role-play the use of a smartphone app!

Explain to the team that for each "category" of components there are methods that are best suited for prototyping and testing that component.

Refer to the component categories and their corresponding methods: Role-playing for interactions; Illustrated sketch of the services; Paper prototypes for digital tools and Physical models for physically feasible products.

Ask the team to review the components they have identified and prioritized and to select a method that fits the "category" of that component.

Ask the teams to start working on a prototype for the component they prioritized. In doing so, they should take care that the priority features, needs



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and limitations of their users are represented in their prototypes. At the end of this task, each team will have created an illustrated sketch, paper prototype, role-play, or physical model (depending on the nature of the component they chose to prototype).

Ask the teams to reflect on what they have produced. Does it meet the needs of their users? Will it be accessible to them? Is it appropriate in the given context?

Ask the teams to think about how they can find out if their prototype works.

3.1.3. TESTING WITH USERS AND FEEDBACK

Recall the closing discussion from the last assignment: How will you know your prototype is working? Ask students to think of times when they were supposed to do something and realized it didn't meet expectations. You can use the example of a test: have you ever completed a test sure that the answers were correct and then received an unsatisfactory grade?

Ask: Wouldn't it be better for them to discuss the questions with the teacher beforehand, get feedback, and then use the feedback to improve their answers on the final test and get an excellent grade?

Explain that that's what prototypes are for, to test our solutions with users, get their feedback, and use it to make a better version that will get a great rating! User feedback helps us know whether our solutions are successful or not. They also help us to discover new needs and requests among users.

Explain that in order to understand whether our prototype is working and what changes would make it better, it is helpful to have a plan for gathering feedback through a range of methods.

Distribute the feedback form to the students ([attachment 2](#)).

Ask participants to think of questions they would prepare for users. Is there anything they're worried that won't work? Is there something they're worried users won't understand? Ask the team to work together to identify three questions they want to ask during user interviews.

Finally, ask the team to identify users to test their prototype with. It is best if the users are representative of their target group and have similar characteristics to their personalities. Ask teams to share the prototype with their user and have each team member observe and record the user's experience.

Ask the teams to reflect: Did their solution work as envisioned? In what ways was the solution successful? And how did the solution fail?

3.1.4. WORKING WITH FEEDBACK INFORMATION

Explain that after you've tested the prototypes, you'll get lots of feedback from users. The next step is to work on understanding the feedback so we can incorporate what we've learned into the new design.

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Go back to the idea of iteration: first we build, then we test, and then we use the findings to build a better version. Emphasize that challenges are not a sign of failure, but a step in the iterative process that even the best companies in the world go through when designing and building new products.

Note: You can make comparisons with Facebook or Instagram—ask the team to consider most of the changes and new features that have been added or removed during the development of these apps based on user feedback.

Ask the team to independently review the feedback and comments and write down the significant findings and observations on sticky notes.

Ask the team: Based on user feedback, what went well? Which elements were difficult for users? Useless? Unclear? Did they satisfy the criteria identified in your user story?

Ask the team to prioritize areas for improvement. Translate the new requirements into user stories and add them to the rest of the work.

Note: if you find it useful, apply a brainstorming process to help the team develop alternatives to the current prototype.

Ask the team to use the new feedback to improve their prototype. Encourage the team to test the new version. It may be most helpful if you test with the same user to see what the impact of the changes is.

Ask the team to think about the impacts of the changes. Have they received more positive feedback from users? Were they able to overcome the challenges of the first test?



Point out that some products and services go through several cycles of prototyping, feedback, and continuous improvement, and that they can use this process to improve the product or service even after it's released or deployed in the field.

Encourage the teams to successfully complete the development and testing phase!

PHASE 4. REALIZATION

After the development and testing of a suitable prototype of the solution to the identified problem, the realization phase follows. In this phase, in fact, it will be necessary to define the necessary resources, make the financial plan, i.e. income and expenses to see the sustainability of the solution and, finally, each team should prepare for a short presentation in which they should present the solution in a convincing way.

4.1. RESOURCES REQUIRED

Explain that even though the work they do is not at all simple, determining the resources needed to make and deliver their product or service is no different than determining the resources when making, for example, a cake.

Ask the teams to imagine that they are preparing a cake for sale.

Ask them what they need to prepare a cake. It is likely that the first answers will be about the



ingredients. Explain: "Ingredients, of course, are the materials that are the resources for your cake." Divide one sheet into four sections and label one of the quadrants "Materials".

Note: depending on the capacities of the team, you must note that those resources are variable. If we need a certain quantity for each cake we want to make, and if we want to

make 10 cakes, then we will have to consider the required quantities of ingredients for 10 cakes.

Ask: What tools do we need to make the cake? The answers will most likely be kitchen utensils, deep bowl, mixer, oven. Label one of the quadrants "Equipment".

Note: depending on the capacities of the team, you can emphasize that these are fixed resources – if I want to make 1 cake, I need 1 mixer; if I want to make 10 cakes I need 1 mixer again.

Ask: What about the person doing the work? So, another input/resource is human resources. In the third quadrant, put the heading "Human Resources".

Ask: And finally, where do you bake the cake? Transporting the ingredients to where the cake is baked and taking the cake to the final location? Advertising the cakes for sale? Those are the last inputs/resources. In the last quadrant, put the heading "Support".

Ask the teams to review their model and prototype to identify the resources needed to manufacture and/or deliver their product or service.

Ask, "What do you need materials for?" It can be anything from paper to document folders, to cooking ingredients!

Ask the teams to write their answers on sticky notes and place them in the relevant squares. Through questions, highlight the materials that the teams may not have identified.

Repeat for the next three questions identifying one or two resources in each section:

- a. What equipment do I need? It can be anything from a hammer to a sieve, to a sewing machine, a laptop or a projector.

b. What do I need human resources for to get the job done? (and what skills must they have?)
It could be a designer, trainer, programmer, or even a doctor.

c. Where and how to support/realize my activities? Do I need to rent a location, transport for myself or the participants, or market my products or services?

Ask the teams to complete their prototype and concept/model analysis and identify resource needs and place a sticky note in each relevant quadrant. Finally, ask the teams to identify what resources they already have available (probably manpower) and what resources they will need to provide.

Explain to the team that essentially a budget is little more than a plan that identifies and defines resource inputs and their costs over a period of time.

Ask the teams to translate the resource needs into a Project Plan: Budget and Budget Narrative.

4.2. SUSTAINABILITY AND INCOME

Ask the teams to think about times when they needed resources to achieve a goal. Give specific examples (eg: "I wanted to buy a phone").

Ask: What strategies did you employ to secure those resources? (examples: "I asked if I could have my brother's old phone" "I sold my old phone to buy a new one", "I asked my parents for money to buy a new phone").

Explain to the teams that the following strategies: generating income, securing finance or meeting costs by securing income are valid strategies to ensure the financial sustainability of the project/activity.

Emphasize that sustainability is considered key to a good intervention and that donors and funders will want to know whether their investment will last even when funding stops.

Ask the team to think about the necessary resources they will need to provide.

Point out that paying for needed resources is one way to secure them; but where will the money come from?

Ask the teams to revise their model, their stakeholder/stakeholder map, and their list of required resources.

Ask the teams if any of their stakeholders could consider funding or paying for their service from the start? Explain that stakeholders who share your vision – your ultimate statement of state and impacts – and who have the resources may be interested in supporting the product and service. Others, such as institutions, may even adopt the project. Ask the teams to discuss and analyze the parties/stakeholders involved and determine if they share the team's vision. On the sticky notes, write down potential donors or institutions.

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Ask the teams if there are parts of their model (product or service) that they can charge a fee for. Explain that in most cases it is not appropriate to charge target users for the service; however, teams may ask themselves what other involved parties/stakeholders (eg: parents) would consider paying for a product or service on behalf of the user? Ask the teams to look at the stakeholder map for possible answers. On sticky notes, write down the involved parties/stakeholders who may pay for parts of the model (product or service).

Finally, ask the teams to revise the remaining input for required resources and the map of involved parties/stakeholders.

Ask: Who would provide resources at no cost (or in-kind contribution)? For example, a municipality may allow young people to use a particular location at no cost; a local NGO can provide technical assistance; members of the target group may volunteer; or a private company can provide free advertising or equipment in return for the company's name to appear next to the project title. On sticky notes, write down the parties involved/stakeholders who have and can contribute, next to the relevant resource.

Finally, ask the teams if there are components in their model that can continue to exist without the necessary resources. For example, trainees can become trainers themselves, eliminating human resource costs. On sticky notes, write down ideas for sustaining program impacts.

Ask the teams to complete the exercise. Reinforce that it's okay if teams don't have an answer for every resource, that's what funding is all about!

Return to the Capabilities and Inputs chart and emphasize that through this exercise the teams are exploring strategies to ensure that their impact is sustained, even when initial funding ceases.

4.3. CRAFTING A PERSUASIVE PRESENTATION

Explain to the team that during the project presentation they will have 5 minutes to "sell" their product or service.

Ask them to think about the last time they heard a persuasive argument—perhaps about a product, service, or social issue. Why was it so convincing?

Explain that the "idea pitch you want to sell" is a short presentation lasting less than five minutes that convincingly conveys the most important information about the proposed product, service or idea and convinces key stakeholders—investors, clients, and even consumers to "buy" your work.

Explain that the ability to "sell" an idea is an essential skill in almost any sector, and that the components of good selling are the same whether you're selling a new or improved toothbrush model, or a new youth empowerment and participation law.

Mark one sheet of flipchart with **"The problem"** and explain that the first step when you want to sell an idea is to communicate the problem. A good introduction will briefly and concisely clarify the problem and identify who is affected by the problem and the size of the affected

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group. Encourage the teams to refer to the problem tree and think about their target group and primary personas.

If the team tackles a problem that is unusual, or not widely known or understood, it helps the team develop additional statements to explain the problem.

Label the second flipchart sheet "**The Solution**" and explain that the second step is to describe the most important elements of the team's proposed solution. Encourage teams to rethink their concept/model, project proposal and activities. Encourage teams to be thorough, but also concise and clear.

Note: if they haven't done so before, ask the teams to name their product or service!

Label the third flipchart sheet "**Advantage**" and explain that the third step is to identify how the proposed solution compares favorably with the team's other efforts to solve the problem (*not how it compares to other teams' work!*), what is unique about this solution, and why this solution will work. (For example: the team that works on recycling may point out that, although the municipality has introduced recycling bins in the past, the bins have never been placed in high traffic areas, and this has not been supported by an awareness campaign that will influence community motivation—and with *this one* project achieves exactly that!).



Label the fourth flipchart sheet "**Objectives**" and explain that the fourth step is to identify what the product or service will achieve. Encourage the teams to refer to the End State and Impact Statement.

Ask the teams to make sub-points for each heading.

Explain to the team that knowing *what* to tell is only one part of a good presentation of the idea we are selling.

Ask the team to think about what, besides *the content*, is important to be convincing. Ask questions to show that it is also very important *how* the presentation was made.

Explain that although a good presentation is based primarily on a good idea, there are also presentation techniques that the team can use to make the presentation more interesting and persuasive.

Ask the team to consider how the following aspects could be reflected in their presentation:

- **Be concise and clear.** A good presentation includes key information but is still short and relevant.
- **Make a connection.** Connect the person you are presenting to with the problem and/or the solution. A great way to do this is by asking questions (eg: "Have you ever walked down the street in Skopje and couldn't find a suitable recycling bin?").

- **Show energy.** Presentations are more effective when the person doing the presentation clearly shows their energy and passion and shows that they enjoy what they are doing.
- **Use visuals.** A picture is worth a thousand words; and rendering is even more useful! Model illustrations (such as model/concept sketches) will improve the team's ability to communicate their solution; showing the prototype will help it generate interest.

Ask the teams to plan how they will make the presentation, including the concepts from above if appropriate.

Conclusion

This Teacher Manual is designed to empower educators with practical tools and methodologies to effectively integrate Problem-Based Learning (PBL) and Design Thinking into their classrooms. These approaches not only deepen student engagement but also equip learners with critical skills such as collaboration, creativity, empathy, and resilience—essential attributes for thriving in the 21st century.

As facilitators, your role in guiding students through authentic, real-world problems will foster a spirit of inquiry and innovation. Encourage reflection, support iteration, and celebrate progress as students take ownership of their learning journeys. Remember, both PBL and Design Thinking are iterative and adaptable—feel free to modify these approaches to suit your classroom needs and your students' unique contexts.

We hope this manual serves as a reliable companion on your journey to inspire meaningful learning experiences and prepare students to become thoughtful, proactive, and solution-oriented citizens of the future.

Module 3. Development of Business Model for implementation of Entrepreneurial Projects in Sustainable Agriculture

Introduction

Sustainable agriculture is an emerging arena for entrepreneurial innovation for every country. Vocational Education needs to adapt to the ongoing continuous changes by embracing **green entrepreneurship**. They need to “create” students that will transform project ideas into viable business models oriented to eco-friendliness. This module focuses on how to develop a **business model** for entrepreneurial projects in sustainable agriculture building on prior modules about sustainability concepts and the design thinking/problem-based learning approach. The module will be a useful tool for educators to help students plan the implementation of their sustainable agricultural innovations through structured business modeling.

The module builds up on EU policies, strategies and initiatives, such as EU Green Deal, emphasizing sustainability and innovation in agriculture. Its main goal is to empower students as *green-agripreneurs*, when developing eco-friendly projects, that always take into consideration the interdependence of economy-society-environment. Green Agripreneurs project analyzed local education strategies for compliance with EU climate goals and consulted agricultural companies to identify needs and trends, ensuring that student projects align with real market gaps and policy priorities. This way, the projects results are relevant to all VET educators and students regardless of the region or the focus product.

By the end of this module, VET teachers will be able to:

- **Understand the role of business models in sustainable agripreneurship.** Teachers will grasp what a business model is and why developing one is crucial for implementing student-driven projects in sustainable agriculture.
- **Explain key concepts and tools** (Business Model Canvas, Value Proposition Canvas, personas, etc.) and how they apply to sustainable agricultural projects.
- **Guide students through business model development.** Educators will be equipped with strategies to help student teams map out the nine elements of a business model for their project, ensuring alignment with the project’s sustainable value proposition.
- **Integrate design thinking outcomes into business planning.** Teachers will be educated on how thinking processes, such as user needs or prototypes can be used for designing a business model.
- **Facilitate stakeholder and community involvement.** The module will enable teachers to involve students, local stakeholders (e.g. farmers, agri-businesses, community members), and even cross-border partners in the development and support of the business model, fostering a participatory approach to sustainable innovation.
- **Evaluate and refine student business models.** Educators will be able to assess the quality and feasibility of student-developed business models (through presentations, pitches, or reports) and provide constructive feedback or evaluation in line with learning objectives and real-world criteria.

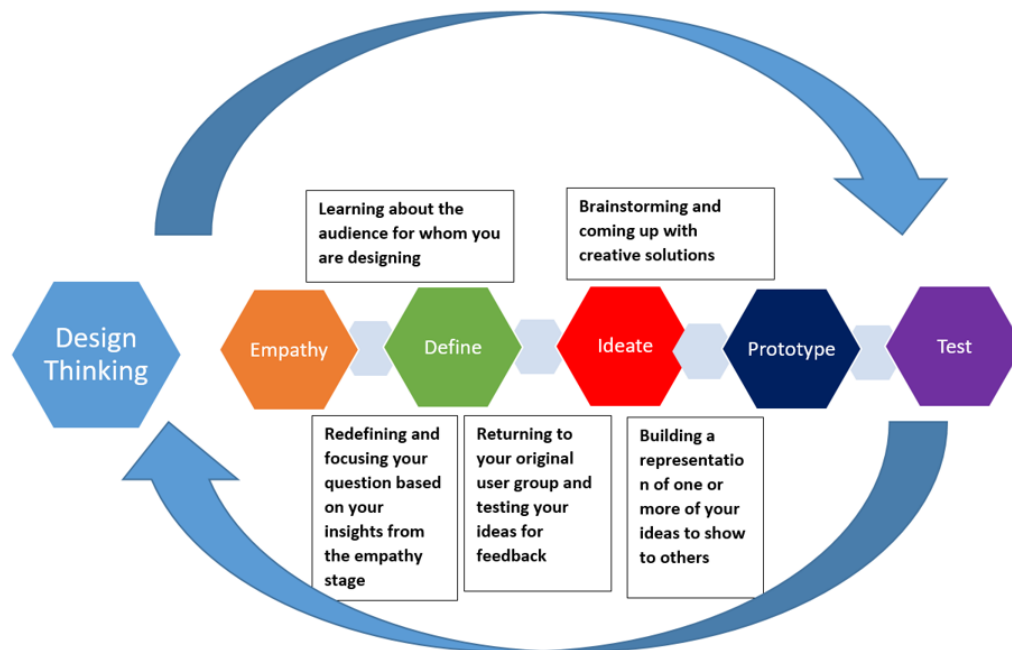


Figure 1: Empathize → Define → Ideate → Prototype → Test, The design thinking process is an iterative, human-centered approach.

Building on the foundations described above (module 1 and 2) we will map out how the resulting solution can operate in practice; who it serves, how it creates and delivers value, and what resources and partnerships are needed. It is really important to highlight the importance of communities to building viable businesses; students and stakeholders are co-creators, which means that students we will need to be educated to create a positive attitude towards direct engaging local farmers, agricultural businesses, and even municipal authorities as mentors or partners. This collaborative dynamic both enriches the learning experience and increases the viability of the projects guiding students to incorporate ideas, feedback, networking, distribution channels etc.

The section that follows is divided into:

- theoretical context
- applied strategies, and tools for crafting a business model (with emphasis on the Business Model Canvas and related methods)
- classroom implementation, with structured guidance, practical steps for teachers
- evaluation approaches and methods both for assessing student learning, as well as identifying the quality of the business plan created

3.1. Theoretical Context, Idea to Business Model

In entrepreneurship education, a **business model** is essentially the blueprint for how a venture creates, delivers, and captures value. It answers fundamental questions:

- Who are the customers or beneficiaries?
- What value (product, service, or benefit) is provided to them?
- How is that value created (activities, resources, partners) and delivered (channels, relationships)?
- And how does the venture sustain itself (revenue streams and cost structure)?

A **Business Model Canvas** provides a one-page overview of the key building blocks of a business idea, ensuring coherence between what is offered and how it operates as a sustainable enterprise. It is important to distinguish a business model from a traditional business plan. A business model (especially when visualized through a canvas) is often a concise, flexible concept that can be iterated and refined, which is ideal for student projects and early-stage ideas. Rather than writing lengthy texts, students can use the canvas to visually map components and see the interconnections immediately. This aligns well with design thinking's iterative nature and allows quick adjustments based on feedback or new insights. Alexander Osterwalder was the one to develop the Business Model Canvas originally, including nine building blocks. More specifically:

The Business Model Canvas

Designed for:
Designed by:
Date:
Version:

Key Partners Who are they? Why? What do they do for you? Who are they? Why? What do they do for you? Who are they? Why? What do they do for you?	Key Activities What key activities must you excel at to deliver your value proposition? What key activities must you excel at to deliver your value proposition? What key activities must you excel at to deliver your value proposition?	Value Propositions What value do you promise to deliver to your customers? What value do you promise to deliver to your customers? What value do you promise to deliver to your customers?	Customer Relationships What type of relationship do you want to establish with your customer segments? What type of relationship do you want to establish with your customer segments? What type of relationship do you want to establish with your customer segments?	Customer Segments Who are the target customers you want to reach? Who are the target customers you want to reach? Who are the target customers you want to reach?
Key Resources What key resources must you possess to deliver your value proposition? What key resources must you possess to deliver your value proposition? What key resources must you possess to deliver your value proposition?		Channels How do you reach your customer segments? How do you reach your customer segments? How do you reach your customer segments?		
Cost Structure What are the most important costs incurred to deliver your value proposition? What are the most important costs incurred to deliver your value proposition? What are the most important costs incurred to deliver your value proposition?			Revenue Streams How do you capture value from your customer segments? How do you capture value from your customer segments? How do you capture value from your customer segments?	

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Figure 2: The Business Model Canvas and its building blocks

- **Customer Segments:** The different groups of people or organizations the enterprise aims to reach and serve. Every project needs a clear understanding of who its target users or customers are. *“Different groups of people or organizations that a company aims to reach and serve”* are identified here. For a sustainable agriculture project, customer segments might include local consumers (e.g. families buying organic vegetables), businesses (e.g. restaurants sourcing from a school garden), or even internal “customers” like the school community if the project’s output is used on campus.
- **Value Propositions:** The bundle of products and services that create value for the customer segments, essentially, why the customers would care. This block defines what problem is being solved or what benefit is delivered. In the context of sustainable agriculture, a value proposition might be *fresh, pesticide-free produce delivered weekly* or *a service that reduces farm waste and turns it into bio-compost*. The value proposition should reflect the sustainable advantage or innovation of the project (e.g. *organic methods that protect soil health* or *using IoT sensors to save water*).
- **Channels:** The means by which the value proposition is delivered to customer segments and how the enterprise communicates with them. Channels include distribution, sales, and communication pathways. For instance, do students plan to sell produce at a local farmers’ market, through a CSA (community-supported agriculture) subscription, or via a school farm stand? Will they promote their project through social media, school events, or local newspapers? The canvas encourages teams to think through *“through which channels do our customer segments want to be reached... how are we reaching them now?”*. Effective channels ensure the project’s offering reaches its intended beneficiaries in a cost-efficient way.
- **Customer Relationships:** The type of relationship the enterprise establishes with each customer segment. This can range from personal assistance (e.g. face-to-face interactions, customer service) to automated services or community building. In a student-led agri project, customer relationships might be very personal and trust-based (e.g. knowing customers by name at the weekly market or engaging the community in educational workshops about sustainability). The canvas asks what relationships customers expect and how those will be maintained.
- **Key Activities:** The most important actions the team must take to deliver the value proposition. These are the core processes or operations of the business model. For an agricultural project, key activities could include growing and harvesting crops (for a farm project), maintaining technology (if it’s an agri-tech solution like a smart greenhouse), conducting workshops (if educational services are part of the model), marketing the produce, etc. Teachers should ensure students focus on activities that truly drive value and not get bogged down in secondary tasks.
- **Key Resources:** The assets required to make the business model work. These resources can be physical (land, tools, seeds, a greenhouse), human (skilled team members, mentors), financial (funding, grants, initial capital), or intellectual (patents, know-how, brand). For example, a school farm’s key resources would include the plot of land, water supply, gardening equipment, compost, and of course the student labor and expertise they’ve gained. An interesting consideration for sustainable projects is that some resources might come from community contributions – e.g. the municipality might provide land or water, or a local business might donate equipment – highlighting the importance of partnership.

- **Key Partners:** The external companies, organizations, or individuals that are essential to the success of the business model. Partnerships can help acquire resources, perform activities, or reach customers that the core team cannot do alone. In student projects, stakeholder involvement is often a key partner dynamic, for instance, a local organic farm cooperating to mentor students (knowledge partner), an NGO or government agency offering a grant or technical support, or a technology provider donating a software license for farm monitoring. For school projects, where students naturally have limited **time, money, and experience**, forming partnerships is highly relevant. Resource optimization, risk reduction, and access to expertise are the keys.
- **Cost Structure:** All the costs incurred to operate the business model. Students must identify what the major costs will be, like seeds, tools, packaging, transportation, marketing materials, etc., as well as fixed vs. variable costs. Are there significant one-time setup costs (building garden beds, purchasing equipment) and what are recurring costs (water, seeds each season, maintenance)? Sustainability projects might also consider costs saved by eco-friendly practices (for example, using recycled materials might lower costs). The canvas encourages an analysis of whether the model is more cost-driven (lean, minimizing expenses) or value-driven (willing to incur higher costs for higher value). This is also a place to discuss any funding model: in a school context, some projects might rely on initial grants or school funds, so students should clarify how those funds cover costs and if the project can eventually be self-sustaining.
- **Revenue Streams:** The ways in which the project will generate income or support to sustain itself. For a business, revenue streams are typically sales of products or services, subscription fees, advertising, etc. In a student agricultural project, revenue might come from selling produce, value-added products (e.g. jam or herbs), providing a service (like compost collection or agro-workshops), or even competition prizes and sponsorships. It's notable that in educational or social entrepreneurship contexts, *revenue* could also include in-kind support or savings. However, since this module frames it as entrepreneurial, students are encouraged to think in terms of actual revenue or funding that keeps the project running. Even if profit-making is not the primary goal (for instance, if the project's aim is educational or environmental), having a revenue model ensures the project's financial sustainability and longevity beyond initial seed funding.

These nine elements form a coherent system. A change in one block can affect others – a fact that students should learn through discussion. For example, if they decide to target a new customer segment (say, supplying produce to a local grocery store in addition to selling at school), that might require new key activities (e.g. packaging and meeting quality standards) and could change revenue streams and cost structure. The Business Model Canvas's strength is in making these relationships visible and encouraging *systemic thinking*. It effectively illustrates the interplay between what the venture offers and what it needs to function. In entrepreneurship education, using the canvas has been shown to improve critical thinking and integration of knowledge.

In the context of **sustainable agriculture projects**, a business model must account not only for economic viability but also for social and environmental value. Many such projects could be considered forms of **social entrepreneurship** or **green entrepreneurship**, where success is measured in community impact and ecological improvement as well as financial returns. For

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example, if students develop a project to convert school cafeteria waste into fertilizer for a community garden, the “revenue” might partly be environmental (reducing waste disposal costs, enriching soil) and social (community engagement), even if they also plan to sell some fertilizer for income. It is useful for teachers to introduce concepts like the *value proposition* extending to social value or *cost structure* including environmental costs/benefits. The Business Model Canvas is flexible enough to incorporate these: students can, for instance, list “reduced carbon footprint” or “improved local biodiversity” as part of the **Value Proposition** if it’s a key selling point, or include volunteer labor (community support) under **Key Resources**. Nonetheless, maintaining a realistic view of finances is important – projects still need to cover costs and sustain operations, so balancing mission and money is a critical thinking exercise.

Another useful tool, a sub tool of Business Model Canva, is **Value Proposition Canvas**, as shown below. This tool zooms into the relationship between Customer Segments and Value Proposition, helping ensure there is a deep connection between the product and the market. The Value Proposition Canvas, also developed by Osterwalder’s team, consists of two sides:

- the Customer Profile (Jobs-To-Be-Done, Pains, and Gains of the customer)
- the Value Map (Products & Services, Pain Relievers, and Gain Creators that the business offers)

Value proposition canvas.

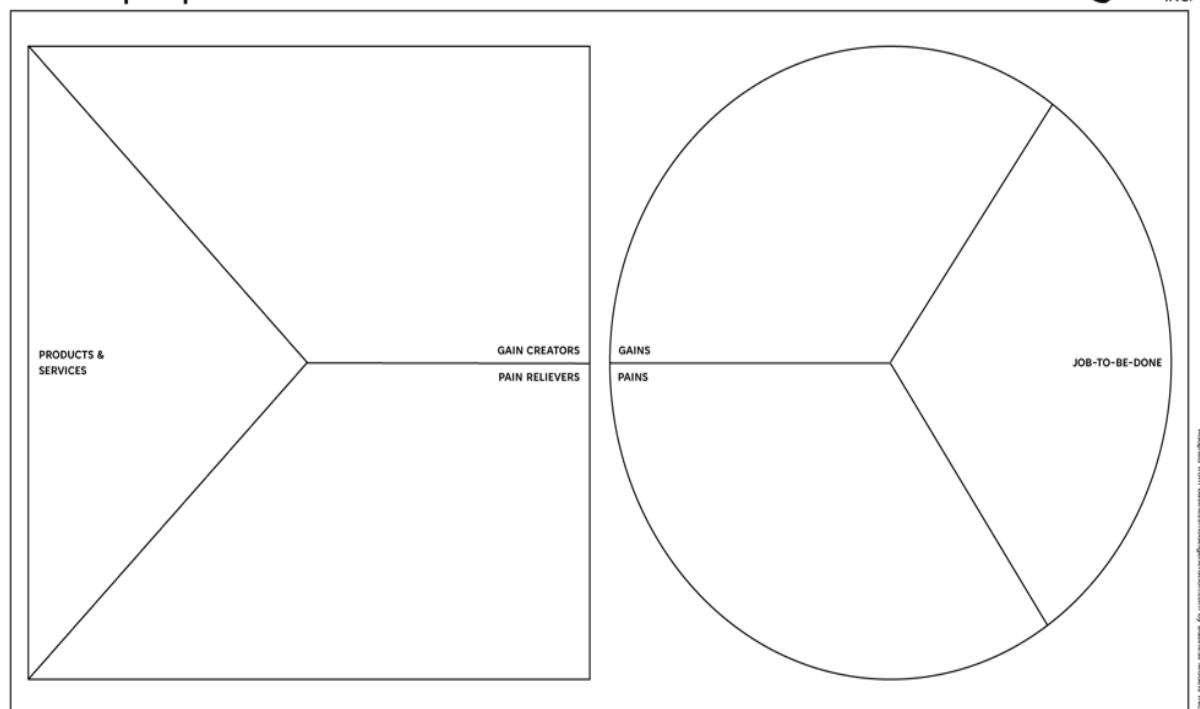


Figure 3: The Value Proposition Canvas

Value Proposition Canvas is meant to answer if what you are offering matches your target group, a tailored product/service to the market.

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For example, in a classroom, a team of students identify a target customer (say, local organic shoppers, or fellow students, or farmers in need of a service), the teacher can use the Value Proposition Canvas to deepen down to:

- **Customer Jobs:** What is the customer trying to accomplish? (e.g. A local gardener's "job" might be to obtain natural fertilizer easily; a school parent's "job" might be to feed their family healthy veggies; a farmer's "job" might be to reduce irrigation costs).
- **Customer Pains:** What annoys or hinders the customer in getting that job done? (e.g. fertilizers are expensive or chemical-laden, organic veggies at the supermarket are pricey or not fresh, irrigation systems are inefficient or labor-intensive).
- **Customer Gains:** What would make the customer happy? (e.g. a free or cheap source of compost that improves soil, getting fresh produce conveniently, a technology that waters crops automatically and saves water).

On the left side, students will need to outline how their solution will deliver:

- **Products & Services:** the actual offerings (e.g. bags of compost, weekly vegetable box, a drip-irrigation kit with sensors).
- **Pain Relievers:** how the offering alleviates the pains (e.g. compost is made from local waste and is free for gardeners, vegetables are grown locally so they're cheaper and fresher, the irrigation kit automates watering saving time and water).
- **Gain Creators:** how the offering adds extra value or gains (e.g. compost improves garden yields, buying school-grown veggies supports education and community, the irrigation system increases crop yield or could qualify the farmer for water-use subsidies).

Using the Value Proposition Canvas will help teachers to ensure a concrete connection between product and market fit, meaning that the solution is something people truly want and will be able to adopt. In the theoretical context of this module, this is vital because many well-intentioned sustainable ideas can fail if they don't actually solve a real problem for someone. By teaching students to articulate the customers' pains and how their idea relieves those pains, we also foster empathy and user-centered thinking. According to the creators of the Value Proposition Canvas, this method forces clarity: *"Identify your customer's major jobs-to-be-done, the pains they face, and the gains they desire... then define how your offering relieves pains and creates gains"*. In practice, teachers might observe an "aha!" moment when a student team realizes, for example, that their initial idea needs to be changed because there's a pain they weren't addressing or a gain they could add. This theoretical grounding in value proposition design will later inform how teachers guide students in refining their business models.

Another theoretical aspect to consider is the concept of the Persona, which means a semi-fictional character representing the target customer. This was touched upon in design thinking (often via empathy maps or persona profiles) and has direct relevance to business modeling. For example, a persona for a student-led organic produce venture could be "Eco-conscious Dimitris, a 35-year-old father who cares about healthy food for his children and supports local initiatives." Defining a persona helps personalize the Customer Segment and keeps students

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focused on real people rather than abstract categories which is a lot of times difficult to comprehend. It ensures that when populating the Business Model Canvas or Value Proposition Canvas, students consistently check: “Would this make sense for Dimitris? Would she be reached by this channel? How would she hear about our project? What would convince her to buy from us rather than a supermarket?”

In summary, the theoretical context of this module blends theory with sustainability principles and the human insights of design thinking. Teachers should understand that developing a business model for a sustainable agriculture project requires balancing of different kinds of value. It's not about profit but about designing a sustainable business idea. This means, as mentioned in the introduction, that the model should be **economically viable, environmentally friendly and socially beneficial**. The tools introduced here, Business Model Canvas, Value Proposition Canvas, personas, etc., are there to provide structure and clarity. They serve as academic and practical frameworks that students can use to systematically think through how to implement their ideas. The next section will move from theory to practice, describing strategies to apply these concepts in the classroom setting, including how to involve students actively in crafting their own business models for sustainable agriculture projects.

3.2. Applied strategies and tools for crafting a business model

This section provides a step by step approaches for teachers to help students develop their business models. Teachers should use Modules 1,2 and the modules described above in an interactive classroom practice, emphasizing on participatory -team building approach. Basically, students should be divided into teams, working to create canvases and iterate on their models, while teachers facilitate and guide the process. Below, seven steps are described, which of course can be differentiated accordingly:

1. Customer and Problem

Teachers should have student teams summarize the problem they are addressing and who experiences this problem (their target user or customer). This acts as a bridge from Module 2 to Module 3. For example, if a team's design thinking process led them to prototype a solar-powered irrigation system for the school's garden, the problem might be "water waste in irrigation" and the target user could be "the school farm manager or student garden club leader." Have the teams articulate the *value proposition* in one sentence: "*We offer [solution] to [customer] to solve [problem] in a sustainable way.*" This specific statement will set up their business model. Encourage them to use evidence gathered during design thinking to justify that the problem is real and their solution has demand. At this stage, a quick stakeholder mapping can be useful: list all the people or groups who might benefit from or be involved in the project. This will be useful to them for identifying customer segments and partners later. It's also a good point to introduce any competitive analysis: ask if there are existing solutions or similar projects, and how theirs is different or better (their competitive advantage, their unique value proposition). While a full market analysis might be too advanced, the concept that "*there are others trying to solve this; here's how we stand out*" is valuable. It links to the Value Proposition – what differentiates their offering.

2. Introducing the Business Model Canvas Template

Provide each team with a large printed Business Model Canvas (or have them draw one on flip chart paper, or use an online canvas tool if computers are available). Ensure it's large enough for sticky notes. Many educators use sticky notes so that ideas can be moved around and changed easily. At this point, it's effective to explain each of the nine blocks in plain language (much as done in the theoretical section), perhaps with a simple example unrelated to their project to illustrate. Teacher should really highlight the interconnection relationship between all blocks, if one box changes, think about what will change to the other. They should emphasize especially the logic from Customer Segments → Value Proposition → the rest. Teachers should direct students to always start working with the customer side, thus filling in the Customer Segment and Value Proposition blocks first.

For the Customer Segment, students must identify the main customer or beneficiary as specifically as possible. If the project serves several different groups, they should list each one (perhaps on separate notes) and later determine if each group requires a distinct value proposition. Teachers should prompt students with key questions, such as "Is this segment large enough and important? Or Should we focus on just one primary segment first?" etc. For the Value Proposition block, students should itemize the core benefits the project offers for each identified customer segment. Teachers need to encourage them to be highly specific and tangible, reflecting on their unique value proposition. A useful tool for easy understanding

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can be the elevator pitch format: “For [Customer segment] who [statement of need or opportunity], our [product/service] provides [key benefit]. Unlike [current alternatives/competitors], we [what distinguishes us].”

When pupils have finalized all above, teachers should integrate the Value Proposition Canvas exercise. Following the Business Model Canva, they will need to distribute and let team work to write down the customer’s jobs-pains-gains and match their product’s features to them. What’s important to mention to students team is that they will need to ensure their value prop to the customer insight.

3. Expand to Other Blocks with Guided Brainstorming

Once the central blocks (Customer and Value) are done, instruct teams to brainstorm the remaining blocks. A good sequence is:

- I. Customer Relationships
- II. Channels
- III. Key Activities
- IV. Key Resources
- V. Key Partners
- VI. Cost Structure
- VII. Revenue Streams

For I and II, teacher should ask students how they plan to find, keep, and grow their customer base. For a student project, initial customers might be friends & family, or community members via activities. Perhaps they’ll leverage school events, or use social media or local. If selling a product, will it be directly to consumer (e.g., at a stall – direct channel) or through a retailer (an intermediary channel)? They should also consider post-sales: how will they get feedback or handle any issues (which ties to relationship – maybe personal follow-up, a Facebook page for the project, etc.). Teachers can share examples: *“If you start a weekly veggie box, one channel is an online form for orders, and relationships might involve sending a newsletter with recipes to your subscribers, building a community around your produce.”* Encourage creativity but also feasibility (e.g., a professional e-commerce website might be unrealistic, but a simple WhatsApp group or a stall at the local market is doable).

For Key Activities, each team should deliver their value proposition. A tip is to have them walk through a day in the life or year in the life of their project. For instance: prepare soil, plant seeds, maintain crops (watering, weeding), harvest, marketing, sales/delivery, manage finances. Also include activities like meeting with partners or obtaining certifications (if needed, say organic certification). If their project includes an educational component (like training other students or awareness campaigns), that is also a key activity. Prioritize activities that directly relate to delivering value or maintaining customer relationships – non-essential activities can be noted but not prioritized. This exercise also reveals if the team is over the line; if the list is too long, it may indicate the model is too complex and might need simplifying or more partners to share the load.

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For Key Resources, teams will need to set up the key activities. A categorization can be helpful. For example:

- Physical resources (land, tools, raw materials, facilities)
- Human resources (skills and labor – who will do the work? Do they need agronomy knowledge, marketing skills, etc.? Perhaps identify roles among team members or need for external help)
- Financial resources (money – do they require a budget, and where will it come from? School funds, crowdfunding, sales revenue reinvestment, grants?)
- Intellectual resources (any special knowledge, designs, brand identity they need)

The discussion here might lead them to realize gaps – e.g., “We need an irrigation system – do we know how to build that? Maybe we need a partner or advisor (which leads to Key Partners).” This naturally flows into the next block.

Key partners main goal is to list the key individuals or legal entities that will be crucial for the projects implementation. For example, typical partners in sustainable agricultural school projects include: local farms or agri-businesses (for mentorship, supplies, or as buyers of output), NGOs or governmental bodies (for expert advice or small grants – perhaps an environmental ministry or a local agriculture extension office), the school administration or other teachers (for permission to use space or integrate project in curriculum), and potentially other schools or international partners (in a transnational project context, maybe exchanging knowledge). So students can consider if any local companies might mentor or support them. They should also consider suppliers as partners if any input is critical. For each key partner, teachers need to advice teams to answer:

- What is the motivation?
- Are they helping reduce risk or cost?
- Providing a resource or performing an activity we can't?.

This clarifies why the partner is needed and can later feed into how to manage that relationship.

Cost Structure can be a difficult block for students to itemize costs. Teachers will need to accumulate them, by brainstorming two main categories:

- One-time/setup costs: building infrastructure (e.g., constructing raised beds, buying a compost bin, developing an app prototype), initial marketing (flyers, banner), or training costs.
- Recurring costs: would include seeds each season, water bills, maintenance, transport fuel, packaging, etc.

Since this could be a difficult task for everybody, especially young people with no experience, it should be mentioned that even if precise numbers aren't available, labeling something as high or low cost is informative. Also teachers should discuss which costs are fixed (don't change with output, like equipment depreciation or a monthly internet fee) versus variable (scale with production, like seed or fertilizer costs per batch). For advanced students, teachers may introduce the idea of economies of scale (if they produce more, does cost per unit drop?). But more importantly for sustainable projects, teachers should focus on discussing any cost-

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saving strategies, which is the main pillar of the project, through sustainability: e.g., using recycled materials (could cut costs), volunteer labor (community service hours instead of paid), etc. By making costs explicit, students can better appreciate the financial viability and consider if their revenue will cover costs.

For the last block, revenue streams, teams will have to detail how and how much money (or support) they expect to bring in. If the model involves sales, what are the pricing schemes? For instance, will they sell vegetables per kilo, or offer subscription boxes (monthly payment)? If it's a service, is it a fee-for service? Are there multiple revenue streams (maybe product sales and workshop fees, or sales and some grant funding, etc.)? For educational projects, sometimes revenue is indirect (like saving the school money on waste disposal is equivalent to revenue). Acknowledge such indirect benefits but also focus on any direct revenue. Exact numbers should not be the main goal here, but students will need to see if orders of magnitude make sense; understanding if the project is profitable or just sustainable by itself. It's very important to highlight how long it might take to break even (cover initial costs) – a concept called break-even analysis.

As teams work through these blocks, the teacher's role is to facilitate and probe with questions. Walking around the room, a teacher might ask one team, "Have you thought about who will use this? How will they get it from you?" or to another, "You listed the school principal as a partner – what will they do for you? Perhaps provide space or promotion?" Such questioning helps students refine their entries. It's also useful to encourage visual thinking – students can sketch logos of partners or simple icons for resources on the canvas to make it more engaging.

4. Involving Stakeholders and Mentors During Development

Moving from step 3 means that each team has developed their own idea and started working on the details. This step focuses mainly on the authenticity of the ideas; how can these ideas involve local or/and regional stakeholders in the business model development process. Teachers can arrange for a "mentor day" or invite a local entrepreneur, farmer, or business coach to give feedback on the teams' canvases. For example, after an initial draft, each team could present their canvas informally to a mentor or even another class/teacher and gather the feedback. This will allow a direct approach to the real world, and it even helps the idea move forward, to validate assumptions or challenge the students to think deeper or outside of the box. Throughout the duration of this step, it's important that teachers encourage their students, and they need to highlight that the outcomes are part of the learning process, an iteration process of improvements and not failure if an idea collapses.

5. Emphasize Community and Environmental Impact in the Model

This step introduces the impact of their Business Canvas Model to the community and to the environment. Since, it's not represented as a block on the Canvas, it should be integrated with the block by the teachers to the canvas. If not, as an alternative, teachers can ask students to mark which blocks address which aspect of sustainability: maybe put a green dot on elements that are eco-friendly or a blue dot on elements involving community. For example, a partner might be the local environmental club – mark that as community engagement. A revenue stream might be selling at fair-trade premium – mark that as supporting fair economy. This exercise ensures they are consciously designing a model that does not stray from the sustainability mission. It also makes cross-border relevance more visible; for instance, the problem of plastic waste or need for organic produce is common across countries, and

showing impact metrics allows comparison and sharing of best practices across the partner schools.

6. Documentation and Presentation of the Business Model

When students develop the canvas, teachers need to encourage them to keep notes explaining each post-it or decision. Ultimately, they will need to **communicate their business model** – to an evaluator, judges, or classmates. A common strategy is to have teams prepare a brief presentation that walks through their canvas. This activity itself is a valuable applied learning strategy, boosting their communication skills and forcing clarity. Teachers can guide students to include in a pitch: problem & solution (value proposition), target market (customer segment), how it works (key activities/resources/partners summarized), and how it sustains itself (revenues vs. costs, with emphasis on the benefit to society/environment).

In the literature, teachers can find a lot of examples on how someone can pitch their idea. In the education framework, especially schools, a simulation like the well-known dragons den is an excellent scenario since it's a non-formal interactive activity which can lead to great results. Teams will need to present to a panel (which could include that mentor or the principal or a local entrepreneur). The panel can ask questions as if they are potential investors or supporters. This gamifies the experience and motivates students to refine their models. Importantly, such presentations and Q&A help students learn to defend and adjust their model under scrutiny, a key entrepreneurial skill.

7. Iteration and Continuous Improvement

Finally, it is undisputed to say that the key idea of success is that a business model is not static. Just as design thinking is iterative, business modeling should be iterative. After initial presentations, give teams time to refine their canvas. Perhaps new questions arose: "We hadn't considered who would maintain the greenhouse during school holidays – a key activity and resource issue." or "Our cost calculations missed the price of organic certification." This is normal and part of learning. Teachers need to encourage them to update the canvas and even test certain assumptions if possible. For instance, one team could do a simple survey of 10 potential customers to validate their price point. This lean startup style approach (build-measure-learn) is very much in spirit of both design thinking and modern entrepreneurship.

Throughout these strategies, the teacher's guidance is crucial in keeping the process structured and ensuring academic level. While students engage in hands-on creation, teachers should connect back to the concepts covered theoretically. For example, when a student says, "We'll rely on donations for funding," the teacher might prompt, "How sustainable is that revenue stream? What happens if donations dry up? Can we think of a revenue stream that is more reliable?" – pushing them to consider a mix of revenue or a plan for long-term viability. The teacher should aim to create a classroom atmosphere akin to an innovation lab or startup incubator. Students are entrepreneurs; the classroom is their workshop for building a venture on paper (or on screen) with constant input, feedback, and refinement. The educator facilitates knowledge (explaining tools), guidance (asking probing questions), and support (arranging mentors, providing resources like templates and examples). By going through this process, students don't just learn *about* business models in theory – they *experience* the

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challenge and excitement of designing one themselves. They practice teamwork, problem-solving, adaptability, and communication – all higher-order skills. And importantly, they remain grounded in the mission of sustainability: all strategies circle back to how their project will promote sustainable agriculture while standing on its own legs as a viable initiative.

3.3. Implementation in the classroom

Implementation in a classroom or workshop requires thoughtful planning to balance instruction, hands-on activity, and reflection. An easy roadmap is presented that can be used as a guidance tool to teachers start delivering all content described.

Duration and Pacing: This module would span several sessions (ideally speaking) (e.g., 4–6 class periods or a mix of classroom and project work time). However, it can be adapted to shorter or longer formats. An example breakdown could be:

- Session 1: Introduction to business models and sustainability in entrepreneurship (theory content; examples; introduction of canvas).
- Session 2: Workshop on Customer Segments and Value Proposition (using Value Proposition Canvas and persona) – teams define their customers and value.
- Session 3: Workshop on completing the Business Model Canvas – teams fill out remaining blocks; teacher and peers provide interim feedback.
- Session 4: Mentor or Stakeholder feedback session, invite guests or rotate teams to critique each other's canvases in a structured way.
- Session 5: Refinement and preparation for presentation, teams adjust their models and create a presentation or poster.
- Session 6: Presentations and Evaluation, teams pitch their business models; feedback from teacher/judges; group reflection on what was learned.

Preparation: Before starting, the teacher should prepare materials: printed canvases, templates (A3 or poster size if possible for group work), sticky notes, markers, tape for putting canvases on walls, and any handouts. If technology allows, consider using digital tools like an online canvas so students can collaborate digitally – especially useful if some team members are remote or for preserving work between sessions. However, physical canvases often encourage more dynamic team interaction in class. Also, assemble any case studies or examples you want to show. Having visuals or a short video about a successful sustainable ag enterprise can be inspiring.

Session 1:

It kicks off by bridging the students' existing Design Thinking solutions to the practical need for a Business Model. Teachers should motivate students by stressing that the goal now is to move their creative ideas from hypothetical concepts into reality. After a brief warm-up activity where the class quickly analyzes the business model of a familiar product (like a fast-food restaurant) to show that everyone can contribute, formally introduce the nine components of the Business Model Canvas. This introduction should be interactive and kept short (20–30 minutes) to prepare for application. Finally, teams should be organized (optimally 3–5

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students) and assign project roles (e.g., Financial Lead, Marketing Lead) to promote diversified collaboration.

Sessions 2-3:

These sessions are dedicated to hands-on teamwork, where students fill out their project's canvas. Teachers circulate, using guided worksheets with prompting questions to ensure teams systematically address all nine blocks. Another idea is to schedule short “**check-ins**”: after, say, 30 minutes of work, pause the class and have each team share one insight or one thing they're stuck on. Peers or the teacher can then quickly advise or share ideas. This breaks up the work and allows cross-pollination of ideas.

Sessions 4-5:

Session 4 focuses on injecting real-world perspective through Mentor/Stakeholder Involvement. Arrange a structured setting, like a roundtable, where teams pitch their canvas to an expert and receive practical feedback. Session 5 is dedicated to Refinement where teams immediately revise their canvas based on the mentor's feedback, potentially conducting quick research to fact-check assumptions. As they finalize their model, the teams must strategically plan their 5–10 minute presentation, learning to prioritize what to communicate. The presentation structure should be strategic: focusing on the Problem then to the Solution then to the Business Model Highlights and finally to the Impact.

Session 6:

Set up the room as an audience setting. If using slides, get them ready; if using posters, display them. Consider inviting a broader audience – maybe other students, teachers, or even parents – to celebrate the work and underscore its importance. This can boost student motivation (performing in front of others). Each team presents. Encourage professional behavior: dress neatly if appropriate, introduce themselves, speak clearly, etc. Remind the audience to be respectful and save questions for after each presentation. During Q&A, ask some tough but fair questions (like what a real investor or evaluator might). E.g., “*What if your main partner backs out? Do you have a backup plan?*”, “*How will you persuade more customers to join after the first year?*”, or “*How do you measure success in environmental terms for this project?*”. The goal is to push their critical thinking one step further and see how they respond under pressure, something they will need to face in their future.

Reflection Group: After all presentations, hold a debrief. This could be a round-table discussion or a written reflection assignment. Also discussing how this process felt, many students find it empowering to see their ideas turn into a structured plan, while others might express that it was hard to think about money or logistics. Acknowledge these feelings and tie them to real-world truths: yes, implementing ideas is challenging but tools like these help break it down; not everyone needs to be a finance expert, but understanding basics will help them in any career; planning is as important as ideation, etc. This reflection solidifies learning.

In conclusion, the classroom implementation of this module is an exercise in applied learning at its finest. It combines subject knowledge (sustainability, business), key competences (entrepreneurial thinking, collaboration, digital skills if using online tools, communication), and real-world engagement (with stakeholders, real problems). For VET educators, this hits the mark of making learning relevant and skills based. Moreover, it contributes to cultivating an entrepreneurial mindset in students. Through the guided steps of this module, students

practice exactly those competences in the context of sustainable agriculture, thereby preparing them not only to possibly run a green business one day but also to be proactive, solution-oriented citizens in their communities.

3.4. Evaluation approaches and methods

Assessing student learning in a module about business model development should address both the process and the product of their work. Given the emphasis on skills like critical thinking, creativity, and collaboration, as well as understanding of content (sustainable agriculture and business concepts), a combination of formative and summative assessment methods is ideal. Many times it can be ignored depending on the framework.

Evaluation of the Module (teacher):

teachers should also evaluate the module's effectiveness for their own practice. After running it, reflect on what went well and what could be improved. Did students grasp the concepts? Were they engaged? Could the balance between theory and practice be adjusted? Did the time feel sufficient?

Assessing Impact and Soft Outcomes:

Beyond the immediate module, teachers and project administrators may assess the overall impact on students. The Erasmus+ project likely has some qualitative and quantitative indicators to track. For instance, they might measure students' self-efficacy in entrepreneurship before and after (via questionnaires), or count how many viable project ideas are actually implemented in schools because of this program, after for example several years.

During training:

Throughout the module, the teacher can understand and take feedback with multiple checking during the canvas development or other steps of the module training. Also, useful information could come up from the feedback from mentors or other teachers participating, (when involving stakeholders and mentors), which is essentially a formative assessment from multiple sources.

Final Product & Presentation:

At the end, if someone follows the schedule reported here, it comes down to the final product and of course the presentation, which includes the communication skills and the business model documentation. This assessment should cover both the content quality of the business model and the communication of it, including:

- Clarity and completeness of Business Model Canvas
- Innovation and Sustainability
- Stakeholder Engagement
- Teamwork and Collaboration
- Presentation Skills

In summary, the evaluation strategy of this module is multi-faceted. It measures knowledge (do students know what a business model is and its components?), skills (can they create and present one effectively?), and attitudes (do they value stakeholder input, do they see

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themselves as capable of entrepreneurial thinking?). Its important to highlight though, that as teachers you should ensure that the students don't just complete a one-off project, but with a sense of accomplishment and a set of tools and mindsets that they can apply in any future endeavor.