

GreenSTEM: Pre-COP31 Workshop Outcomes Report

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Executive Summary

Organised under the project “GreenSTEM: STEM Entrepreneurship for Green Circular Economy”, the Pre-COP31 Workshop brought together representatives of industry and business, universities, vocational and technical education institutions (STEM teachers), public institutions and civil society organisations at seven thematic roundtables. It discussed how far science, technology, engineering and mathematics (STEM) education in universities and vocational and technical education institutions meets the needs arising from the green transition of business, and why some needs remain unmet. This report analyses the seven roundtable discussions thematically and presents the common findings; Figure 1 gives the workshop and the analysis in numbers.



Figure 1. The Pre-COP31 Workshop in Numbers

As Figure 1 shows, the seven thematic roundtables yielded ten common themes, nineteen challenges, fifteen development needs and two horizontal principles (two conditions to be observed in all activities).¹ Figure 2 summarises the ten themes.

Employers' weak and indirect demand for green skills - Green skills are not yet sought in recruitment. - Demand reaches businesses indirectly, from export customers, EU regulations and banks.	Course credit and accreditation constraints - Credit limits and accreditation rules leave no room for new content. - Existing content introduces the subject; it does not teach green transition measurement and calculation.	Students' limited access to practical opportunities - Internship places cannot be found; insurance and cost burdens deter businesses. - University laboratories are inadequately equipped.	Vocational-technical education gaps; disconnect between levels - Graduates' production experience is weak. - These institutions cannot find businesses for student practice. - School, upper secondary and university are disconnected.	Knowledge is not turned into products and ventures - Students lack skills in presenting ideas and in cost and market knowledge. - IP rights and shares of contribution are not set in advance.
No contact point between universities and business - Producers and businesses do not know whom to approach at the university. - Support is scattered across institutions.	Learning needs of managers, employees and educators - Unless management takes ownership, the green transition remains on paper. - Educators lack knowledge of teaching methods and assessment.	Certificates and documents do not reflect real competence - Certificates and internship documents do not reflect real skills. - Employers look at experience and references rather than documents.	Inequality in access to opportunities - Women and rural and small producers cannot access opportunities. - Students cannot meet internship and transport costs.	Difficult field conditions of the waste recovery chain - Waste is not separated at source; collection and transport are hard. - Waste quantities are not measured. - Legislation and practice diverge.

Figure 2. Main Findings

The ten headings in Figure 2 summarise the themes in Section 4; their order does not indicate importance. The findings show a mismatch between STEM education and the needs of business that does not stem from the shortcomings of one side alone. Employers have not yet defined green skills (the knowledge and skills the green transition requires) and do not seek them in recruitment; demand for such employees arises largely from the expectations of customers in export markets and from European Union (EU) regulations. Education institutions, for their part, leave applied skills such as measurement and calculation related to the green transition, knowledge of legislation and experience in a business environment out of their curricula. The university contact units available to businesses and producers, and work-based learning opportunities such as internships and on-the-job training, are inadequate. Participants' disagreements are addressed separately below.

¹ As used in European Union cohesion policy: a requirement, such as gender equality, non-discrimination or sustainable development, applying to all programmes at every stage (Regulation (EU) 2021/1060, 2021, Article 9).

1. About the Workshop

GreenSTEM is a project coordinated by Sakarya University and supported under the Higher Education Initiative of the European Institute of Innovation and Technology (EIT HEI). The project aims to develop the entrepreneurial competences of STEM² students in the field of the green and circular economy. The findings of the Pre-COP31 Workshop will provide the basis for the education design work of the GreenSTEM project.

The workshop takes its name from the 31st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP31). COP31 will be held in Antalya from 9 to 20 November 2026 (United Nations Framework Convention on Climate Change [UNFCCC], 2026). The hosting of the conference in Türkiye offered an opportunity to address the education and skills dimension of the climate agenda with local stakeholders ahead of the conference; the workshop was therefore designed as a preparatory event for COP31 and held in Sakarya. The workshop findings are intended to feed into GreenSTEM's work on the COP31 process. The main aim of the workshop was to identify the challenges encountered in aligning STEM education in universities and vocational and technical upper secondary institutions with the demands of the market and of business, and to determine development needs on the basis of these challenges.

The workshop opened with a session introducing the project and continued with discussions held simultaneously at seven thematic roundtables. The roundtable topics were determined by the Organising Committee on the basis of GreenSTEM's education modules and fields of work (green skills and STEM competences, the transition from research to application, the circular bioeconomy and the valorisation of agricultural waste, sustainability reporting, sustainable food systems and biotechnology, interdisciplinary problem-based learning, and women's entrepreneurship in the green economy), so that each roundtable would provide direct input into the project's education design. The discussion at each roundtable was conducted as a focus group led by a moderator; a separate set of questions was used for each roundtable, and the discussions were recorded by rapporteurs. The rapporteurs' notes were monitored in real time via Google Docs during the workshop; where the flow of data was insufficient or interrupted, the rapporteurs were contacted, the causes were investigated and the problems were resolved. This monitoring did not interfere with participants' views; it supported the continuity of the data flow, the quality of the records and the maintenance of a common recording standard across roundtables. Data saturation, the point at which new entries in the notes began to repeat earlier content and the discussions were no longer producing new information, was identified through the observation of the Organising Committee members monitoring the notes and confirmed by the moderators. The rapporteurs' notes compiled up to that point were then transferred to an AI-assisted note-taking and visualisation tool (Gemini Notebook), and thematic mind maps were produced during the workshop. The themes that became visible in these maps were opened for discussion at the GreenSTEM Project Consortium Evaluation Table, composed of representatives of the project partner institutions (consortium members); the members were asked to assess, on the basis of these themes, the difficulties faced from the project's perspective

² STEM is the acronym formed from the initials of science, technology, engineering and mathematics; it is used to refer to the educational approach in which these four fields are taught in relation to one another, and to the curricula in these fields.

and the problem areas that needed to be addressed. Although the Evaluation Table could be regarded organisationally as an eighth table, it was not a workshop roundtable producing independent data in the way the seven thematic roundtables did; its discussions were neither analysed as a separate data set in this report nor treated as a validation of the findings. Figure 3 shows the seven thematic roundtables and how the workshop operated.

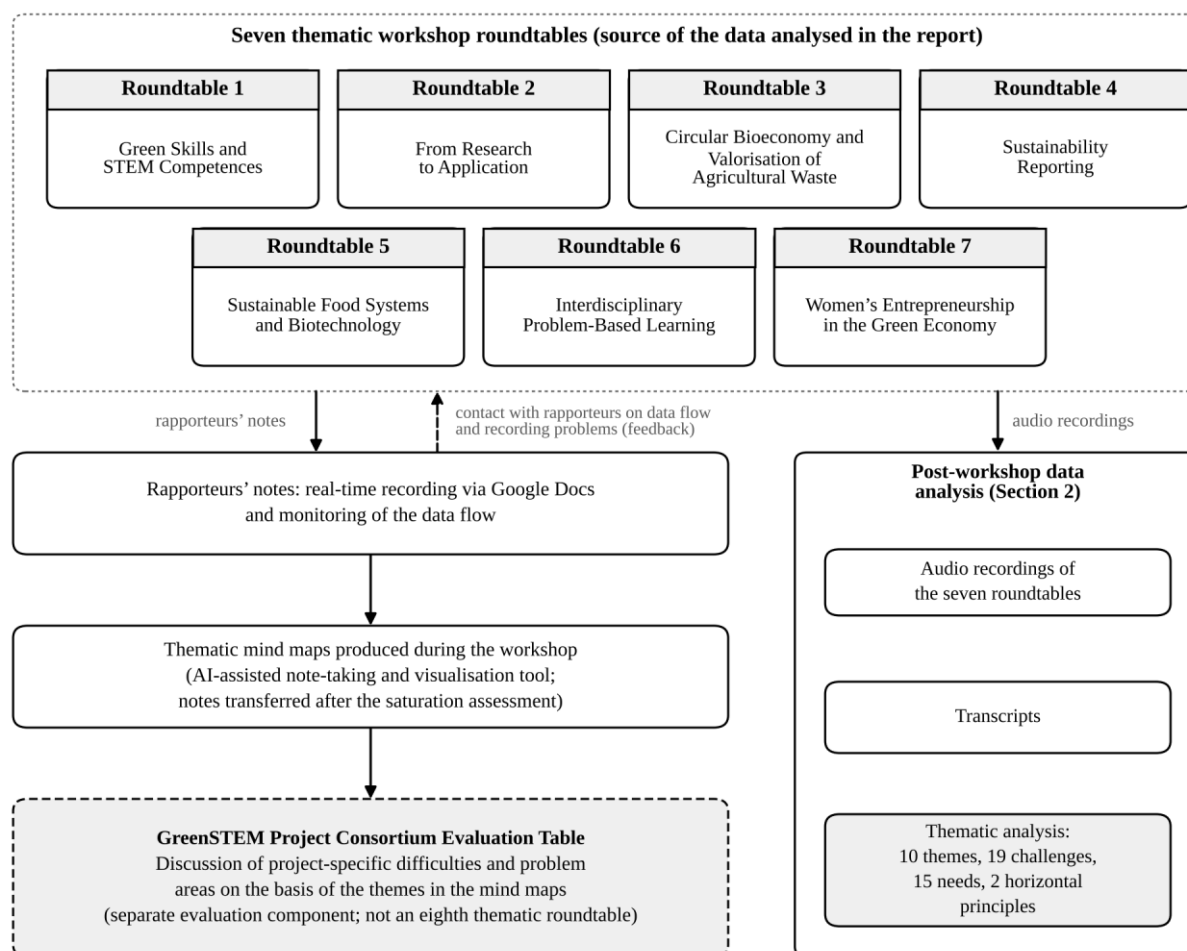


Figure 3. Workshop Roundtables and the Operation of the Workshop

Figure 3 shows two separate flows. In the flow during the workshop, the rapporteurs' notes were monitored in real time, made visible through mind maps and formed the agenda for discussion at the Evaluation Table; the function of the AI-assisted tool was limited to these three steps. The analysis presented in this report is based not on these visualisations but on the transcripts produced from the audio recordings of the seven roundtables (Section 2). The focus of discussion at each roundtable is given in Section 3 (Table 1 to Table 7). The groups that took part in the roundtables are shown in Figure 4.

	University	Business	Public Institutions	Civil Society Organisations	STEM Teachers
Roundtable 1	●	●	●	●	●
Roundtable 2	●	●	●	●	●
Roundtable 3	●	●	●	●	●
Roundtable 4	●	●	●	○	○
Roundtable 5	●	●	●	●	●
Roundtable 6	●	○	○	○	●
Roundtable 7	●	●	●	●	○

Figure 4. Participant Groups by Roundtable

Note: Black circles indicate that at least one participant from the relevant group was present at the roundtable. White circles indicate that the group was not represented at that roundtable. The University column covers faculty members working at universities. The Business column includes managers, employees and entrepreneurs from businesses operating in manufacturing, energy, chemicals, pharmaceuticals, food, recycling and consultancy. The Public Institutions column covers representatives of public bodies such as the Sakarya Directorate of Education, municipalities and the regional development agency; the Civil Society Organisations column covers representatives of voluntary organisations such as associations, cooperatives and city councils. The STEM Teachers column refers to participants who work in schools affiliated to the Ministry of Education and conduct STEM education and projects with their students.

As Figure 4 shows, representatives of industry and business, universities, public institutions and civil society organisations, together with STEM teachers, took part in the roundtables. The composition of participants varied between roundtables: Roundtable 6 included only university representatives and STEM teachers working in vocational and technical education institutions; no STEM teacher was present at Roundtables 4 and 7, and no civil society organisation representative at Roundtables 4 and 6. Figure 4 and the participant profiles in Section 3 cover the seven thematic roundtables; the consortium members at the Evaluation Table are not included in these counts. The method of analysis is explained in the following section.

2. Method

The data analysed in this report are the transcripts produced from the audio recordings of the discussions at the seven thematic roundtables. The thematic mind maps produced during the workshop and the discussions at the GreenSTEM Project Consortium Evaluation Table were not included in the analysis as data; the function of these tools and of this structure is explained in Section 1. The transcripts were analysed using the thematic analysis approach of Braun and Clarke (2006, 2022). Thematic analysis is a method based on identifying, analysing and reporting recurring patterns of meaning within qualitative data. The analysis was conducted in five stages (Figure 5): the transcripts were read in full; each meaningful statement was given a label (code) summarising its content; similar codes were grouped under common headings (themes); concrete obstacles raised at two or more roundtables were listed as challenges; and the arrangement or resource required to overcome each challenge was defined as a development need. Coding was inductive, that is, the codes were derived from the text rather than determined in advance; roundtable names or predetermined categories were not used as codes.

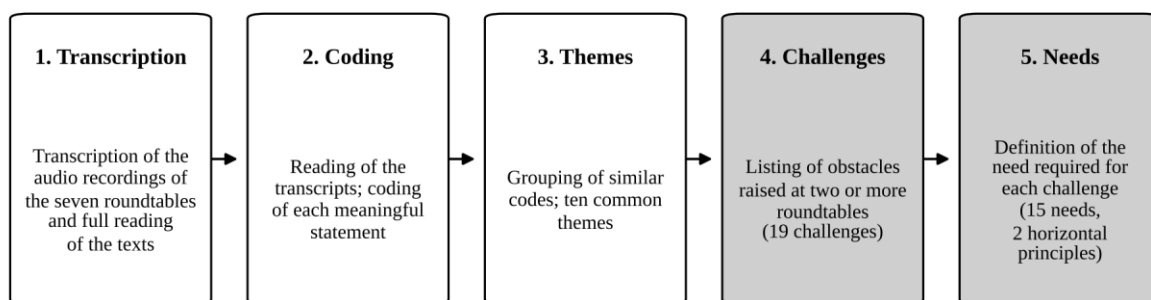


Figure 5. The Five Stages of the Analysis

Note: White boxes show the stages in which participants’ statements were read, coded and grouped under themes; grey boxes show the stages in which challenges and needs were defined according to criteria set by the report team.

The first three stages in Figure 5 cover the reading and coding of participants’ statements and their grouping under themes. In the last two stages, challenges and needs were defined according to criteria set in advance by the report team: concrete obstacles raised at two or more roundtables were recorded as challenges, and the arrangement or resource required to overcome each challenge as a development need. This distinction keeps findings that rest directly on participants’ statements separate from classifications made according to criteria. Three principles were observed in the analysis. First, questions, summaries and examples offered by the moderators were not treated as findings. Second, marking a topic for a roundtable indicates that at least one participant at that roundtable raised the topic; it does not indicate the number of participants sharing the view, the existence of consensus or the importance of the topic. Third, numerical information reported by participants was not used as evidence, since it could not be verified. The report does not name individuals or institutions; the findings are reported at the level of roundtables.

3. Roundtable Results

This section presents the results of the seven thematic roundtables in a common format: focus of discussion, participant profile, key findings, points of disagreement and implications for education. In each table, the first four rows convey participants’ views and the last row contains the report team’s assessment. Each table is followed by a brief note on how the roundtable’s findings relate to the themes in Section 4.

Roundtable 1. Green Skills and STEM Competences

Roundtable 1 addressed green transition practices in businesses and the skills sought in recruitment; the results are summarised in Table 1.

Table 1. Roundtable 1: Focus of Discussion, Key Findings and Implications for Education

Roundtable 1. Green Skills and STEM Competences	
Focus of discussion	Green transition practices in businesses, the skills sought in recruitment, the skills that can be acquired at school and on the job, workplace training, and the barriers faced by women and young people.
Participant profile	Faculty members; a STEM teacher; a project coordinator from the Sakarya Directorate of Education; representatives of manufacturing, energy and consultancy companies; a civil society organisation representative.
Key findings	Business representatives stated that green awareness is not sought in recruitment and that the basic criterion is willingness. According to the faculty members, demand for green skills arises in businesses only when it becomes compulsory, and sustainability reports are often prepared solely in order to obtain a document.
	Adding new content to curricula is made difficult by the credit limit of the European Credit Transfer and Accumulation System (ECTS) and by programme accreditation rules; existing course content remains theoretical. An industry representative stated that graduates of vocational and technical education institutions and of universities have insufficient knowledge of materials and that apprenticeships are run without supervision. Vocational and technical education institutions were said to have difficulty finding businesses that would offer students practical placements.
	It was proposed that workplace training should start with senior management and be repeated at regular intervals. Collection and transport problems in the deposit return system, under which packaging waste is collected against a refund, and the re-mixing of separately collected waste were given as examples of implementation failures in waste management.
Points of disagreement	While the STEM teacher held that technical gaps are filled on the job in the sector, a faculty member argued that acquiring these skills on the job would come too late. One participant described the association of cleaning and recycling jobs with women as an inequality, while another stated that they had not observed discrimination in recruitment.
Implications for education	Course content on the green transition (carbon, energy and waste management, the circular economy) should be integrated into existing courses rather than offered as separate programmes; experience of materials and production in vocational and technical education institutions, and training that starts at management level in businesses, should be strengthened.

The findings of Roundtable 1 underpin several of the themes in Section 4, chiefly the weakness of employers’ demand for green skills (Theme 1), course credit and accreditation constraints (Theme 2) and the shortcomings of vocational and technical education (Theme 4); the proposals on workplace training are addressed under Theme 7.

Roundtable 2. From Research to Application

Roundtable 2 addressed the process of transferring research results to products and markets; the results are summarised in Table 2.

Table 2. Roundtable 2: Focus of Discussion, Key Findings and Implications for Education

Roundtable 2. From Research to Application	
Focus of discussion	Transferring research results to products and markets; the skills expected of graduates; internships, infrastructure, intellectual property rights and working conditions.
Participant profile	Faculty members; representatives of the chamber of commerce and industry, the municipality and the regional development agency; a civil society organisation representative; a STEM teacher.
Key findings	According to the faculty members, undergraduate students encounter advanced industrial problems only in their final-year projects. Students have difficulty presenting their ideas, integrating information and establishing cause-and-effect relationships.
	It was stated that students cannot evaluate laboratory outputs as a commercial product and that their prototyping, design thinking and branding skills are inadequate. According to the regional development agency representative, the first year of a start-up requires business management, persuasion, accounting and marketing skills. The same participant stated that a structure is needed to match industry with the university.
	The chamber of commerce and industry representative stated that students have no knowledge of the business environment or of waste types. It was reported that internship places cannot be found because of insurance obligations, that laboratory infrastructure is outdated and that patent processes are not known. An example was given of an idea being used by another institution because no written record had been kept. Engineers were reported to be employed, at minimum wage level, in jobs that do not match their abilities and do not require engineering knowledge.
Points of disagreement	Views differed on whether companies can access universities' laboratory and equipment inventories.
Implications for education	Skills for turning a business idea into a product and knowledge of intellectual property rights should be included in course content. Long-term internships and a university-industry matching structure should be supported by institutional arrangements.

The findings of Roundtable 2 feed chiefly into the themes of knowledge not being turned into products and ventures (Theme 5) and students' limited access to practical opportunities (Theme 3); the observations on intellectual property rights and on employment conditions are addressed under Theme 5 and Theme 1 respectively.

Roundtable 3. Circular Bioeconomy and the Valorisation of Agricultural Waste

Roundtable 3 addressed the obstacles to turning the region’s agricultural waste into products, and STEM education for the circular economy; the results are summarised in Table 3.

Table 3. Roundtable 3: Focus of Discussion, Key Findings and Implications for Education

Roundtable 3. Circular Bioeconomy and the Valorisation of Agricultural Waste	
Focus of discussion	Agricultural waste in the region; the obstacles to turning waste into products; STEM education for the circular economy, internships, laboratory infrastructure and school-level activities.
Participant profile	Representatives of recycling, pharmaceutical and chemical companies; a representative of an agricultural development cooperative; a faculty member and an engineer working at the university; a STEM teacher; municipal staff.
Key findings	The region’s main agricultural wastes are hazelnut husks (the green outer husk), hazelnut shells and poultry manure. The obstacles to turning waste into products were listed as difficulties in collection, transport and storage, the seasonality of the raw material, gaps in legislation and dependence on imports for inputs such as activated carbon, peat and coco peat; the value created was said not to reach the producer.
	Education was judged to be predominantly theoretical and based on rote learning. It was reported that students cannot find internship places, that businesses regard interns as a burden because of occupational safety risks and costs, and that some internships are documented without actually being carried out. Equipment procurement processes at public universities were said to take up to two years.
	The cooperative representative stated that producers do not know whom to approach at the university and proposed an advisory unit. STEM activities in schools were said to remain at the prototype stage, with their intended learning outcomes not clearly defined.
Points of disagreement	One view held that the final semester should be spent in a business; another held that current internship practices are dysfunctional and that practical work should be built into the curriculum. Who should establish the link between the university and producers was also among the issues debated.
Implications for education	Compiling an inventory of the region’s waste and a preliminary feasibility study could be designed as a course assignment for students based on real data. Establishing a contact unit at the university to which producers can turn, and opening laboratories to producers, require a decision by the university management.

The findings of Roundtable 3 are among the main foundations of the themes of the field conditions of the waste recovery chain (Theme 10), students’ limited access to practical opportunities (Theme 3) and the lack of a contact point between universities and business (Theme 6); the access difficulties of small producers are assessed under Theme 9.

Roundtable 4. Sustainability Reporting

Roundtable 4 addressed the data, skills and education infrastructure required for sustainability reporting; the results are summarised in Table 4.

Table 4. Roundtable 4: Focus of Discussion, Key Findings and Implications for Education

Roundtable 4. Sustainability Reporting	
Focus of discussion	Collecting carbon, energy and waste data; the skills of those who will carry out sustainability reporting; common errors; the customer and export dimension; education infrastructure and entrepreneurship.
Participant profile	Faculty members, a regional development agency expert and representatives of consultancy and engineering companies.
Key findings	According to the participant from the consultancy sector, knowledge of sustainability is not yet sought in recruitment. Nevertheless, exporting companies are turning to these issues out of necessity. Banks and corporate customers have begun to request sustainability reports and scores.
	Students' knowledge of sustainability was judged to fall below the level of basic literacy. Participants put forward four proposals: a compulsory common sustainability course for all departments, the addition of subject-related sustainability content to every course, courses on data science and on standards and legislation, and financial literacy training in all departments. A separate undergraduate programme in sustainability was considered unnecessary.
	It was stated that where management does not take ownership, sustainability efforts remain on paper, and that efforts to appear green at the level of packaging can turn into greenwashing (presenting a product as more environmentally friendly than it is). The agenda was said to be shaped by external obligations such as the EU Carbon Border Adjustment Mechanism (a regulation under which a charge is levied on goods exported to the EU according to their carbon emissions).
Points of disagreement	Who should carry out sustainability reporting is contested: one view holds that the reporting framework should be established by engineers. Another holds that reporting is not the preserve of any single profession and that what matters is the ability to see the whole picture. Views also differed on the importance customers attach to the report.
Implications for education	Measurement, sustainability reporting and knowledge of legislation should be taught with real business data, and sustainability content should be spread across all departments rather than confined to a single branch of engineering.

The findings of Roundtable 4 support the themes of employers' demand for green skills arising from external obligations (Theme 1) and course content remaining at the level of awareness (Theme 2); management's lack of ownership is addressed under Theme 7, and the view that short certificate programmes would benefit graduates under Theme 8.

Roundtable 5. Sustainable Food Systems and Biotechnology

Roundtable 5 addressed losses in the food chain, graduates' skills and the valorisation of by-products; the results are summarised in Table 5.

Table 5. Roundtable 5: Focus of Discussion, Key Findings and Implications for Education

Roundtable 5. Sustainable Food Systems and Biotechnology	
Focus of discussion	The stages at which losses occur in the food chain and their measurement, graduates' skills, labelling, small businesses and cooperatives, and the valorisation of by-products.
Participant profile	Faculty members, a food company manager, an expert from the Sakarya Directorate of Education, a civil society organisation representative and a STEM teacher.
Key findings	Food loss was said to be concentrated in households, schools and the food service sector; according to the company representative, losses at the production stage are low and losses at the last link of the chain (the consumption stage) are high. It was stated that losses are not measured and that farmers produce without market information.
	According to the company representative, graduates start work without a command of food legislation and learn the legislation in the business. A need for training in labelling was noted; an example was given of an administrative sanction incurred because the rules on product naming were unclear. It was stated that references and corporate experience are taken into account in recruitment and that businesses show limited interest in certificate and training programmes.
	Students were said to have insufficient contact with businesses; trade fairs, company visits, a six-month practical period and a compulsory practice-based course were proposed. No legal obstacle was seen to the valorisation of by-products; demand and added value were stated to be the decisive factors.
Points of disagreement	Views diverged on supporting small producers: the STEM teacher proposed that farmers could be trained at public education centres and set up their own ventures, while the company representative argued for focusing on ventures with added value and demand.
Implications for education	Measuring food loss and developing products from by-products should be taught together with legislation and labelling rules, and practice should be designed as a compulsory and assessed component of a course.

The findings of Roundtable 5 contribute to the themes of graduates' lack of knowledge of legislation (Theme 2), students' limited contact with businesses (Theme 3) and the failure to measure waste quantities (Theme 10); the disagreement on supporting small producers is addressed in Section 5.3.

Roundtable 6. Interdisciplinary Problem-Based Learning

Roundtable 6 took interdisciplinary problem-based learning as its subject and addressed the assessment of teamwork, rights in student work and the certification of acquired skills; the results are summarised in Table 6.

Table 6. Roundtable 6: Focus of Discussion, Key Findings and Implications for Education

Roundtable 6. Interdisciplinary Problem-Based Learning	
Focus of discussion	The assessment of teamwork, rights and confidentiality in the solutions students produce, continuity between upper secondary school and university, and the certification of acquired skills for employers.
Participant profile	Faculty members and STEM teachers working in vocational and technical education institutions.
Key findings	In teamwork, assessment scales are used in which students rate one another (peer assessment), the work process and the resulting product; however, students were said to tend to give one another high marks in peer assessment. It was proposed that scales be prepared according to learning outcomes, that educators receive training in assessment and evaluation, and that STEM teams include a social scientist.
	Examples were given of disputes arising because each member's share of contribution in teamwork had not been determined in advance; it was proposed that a written agreement be reached at the start of each piece of work and that the student's right to present the work in their portfolio, the right to use it in teaching and the patent right be defined separately.
	It was stated that there are educators who resist interdisciplinary problem-based learning and insist on traditional methods. Students with relatively lower academic skills were said to be placed in vocational and technical education institutions, yet to take part in production processes thanks to their practical knowledge and skills. Short training courses in vocational and technical fields were said to be documented only with a certificate of attendance; a document showing the aim of the training, its assessment activities, learning outcomes, duration and its equivalent in course credit or grades was proposed.
Points of disagreement	No marked disagreement is apparent in participants' statements.
Implications for education	Assessment tools that make individual contributions visible in team projects, a rights agreement signed before work begins, and documents with clearly defined content provide direct input into education design.

The findings of Roundtable 6 are among the foundations of the themes of educators' capacity in assessment and evaluation (Theme 7), certificates and documents not reflecting real competence (Theme 8) and intellectual property rights not being determined in advance (Theme 5); the observations on vocational and technical education institutions are assessed under Theme 4.

Roundtable 7. Women’s Entrepreneurship in the Green Economy

Roundtable 7 addressed the barriers faced by women who set up ventures in the green economy and the arrangements for supporting them; the results are summarised in Table 7.

Table 7. Roundtable 7: Focus of Discussion, Key Findings and Implications for Education

Roundtable 7. Women’s Entrepreneurship in the Green Economy	
Focus of discussion	The barriers faced by women who set up ventures in the green economy, the sustainability of their businesses, whether women are taken seriously as counterparts, and the knowledge and skills needed by women who will set up a venture or work in this field.
Participant profile	A faculty member, civil society organisation representatives, a social enterprise consultant, a trainer from a public institution and women entrepreneurs.
Key findings	Support was said to be scattered across different institutions, and success to be monitored by the number of women entrepreneurs supported rather than by quality. Institutional language was said to alienate rural women, and accounting, invoicing and digital skills to be inadequate.
	Women were said not to be represented on the boards and advisory committees of chambers of commerce and industry, and industry and business networks to be male-dominated. Companies exporting to the EU were said to be asked for carbon footprint and energy consumption data, with practices remaining on paper where there is no inspection.
	The solutions proposed were incubation centres that bring support together at a single point, matching entrepreneurs with academics, local industrialists offering trial opportunities at their production facilities, business model training, and monitoring the results of support through sales data.
Points of disagreement	Whether access to finance is a problem specific to women, whether support should be provided by the state or through a regional fund, and whether women should be directed to entrepreneurship networks in major cities or supported locally were debated.
Implications for education	The findings point to three education needs that would support women’s participation in green STEM fields and their conversion of technical knowledge into economic value. Applied technical training in measuring the carbon footprint and energy consumption data demanded by export markets and in sustainability reporting could enable this demand to be met through knowledge of measurement rather than merely by producing documents. Financial and digital skills training covering accounting, invoicing and digital tools directly addresses the gap identified in relation to the sustainability of ventures. Local industrialists offering trial opportunities at their production facilities and the matching of entrepreneurs with academics could be designed as a work-based learning arrangement that provides women entrepreneurs with applied learning and mentoring. It is recommended that this training be delivered locally, in accessible language and under conditions that facilitate women’s participation.

The findings of Roundtable 7 are the main foundations of the themes of inequality in access to opportunities (Theme 9) and the lack of a contact point and coordination between universities and business (Theme 6); the disagreements at this roundtable are addressed in Section 5.3. From the perspective of STEM education, these findings indicate that women’s participation in the green economy needs to be supported not only through entrepreneurship support but also through measurement and sustainability reporting, digital and financial skills, and applied learning opportunities in production settings. The intersecting findings of the roundtables are presented as themes in the following section.

4. Common Themes

Coding the transcripts of the seven roundtables together yielded ten common themes. Each theme names a common problem area that was expressed in different words at different roundtables. Table 8 shows the themes and the roundtables at which each theme emerged.

Table 8. The Ten Common Themes and Their Distribution across Roundtables

Themes	1	2	3	4	5	6	7
Theme 1. Employers’ weak and indirect demand for green skills	X	X	X	X	X		X
Theme 2. Course credit and accreditation constraints and course content that remains at the level of awareness	X	X	X	X	X	X	
Theme 3. Students’ limited access to practical opportunities	X	X	X		X		
Theme 4. Shortcomings in vocational and technical education and the disconnect between levels of education	X		X		X	X	
Theme 5. Knowledge not being turned into products and ventures	X	X	X	X	X	X	X
Theme 6. Lack of a contact point and coordination between universities and business	X	X	X			X	X
Theme 7. The learning needs of business managers, employees and educators	X	X	X	X	X	X	X
Theme 8. Certificates and documents not reflecting real competence	X	X	X	X	X	X	
Theme 9. Inequality in access to opportunities	X	X	X	X	X		X
Theme 10. The difficult field conditions of the waste recovery chain	X	X	X	X	X		X

Note: The numbers in the column headings are roundtable numbers; an X indicates that the topic was raised by at least one participant at that roundtable.

According to Table 8, Themes 5 and 7 emerged at all seven roundtables, and Themes 1, 2, 8, 9 and 10 at six. Theme 6 was confined to five roundtables and Themes 3 and 4 to four. In line with the principle stated in Section 2, this distribution shows how widespread the topics were across roundtables, not their degree of importance. The report authors’ interpretation of how the themes relate to one another is summarised in Figure 6.

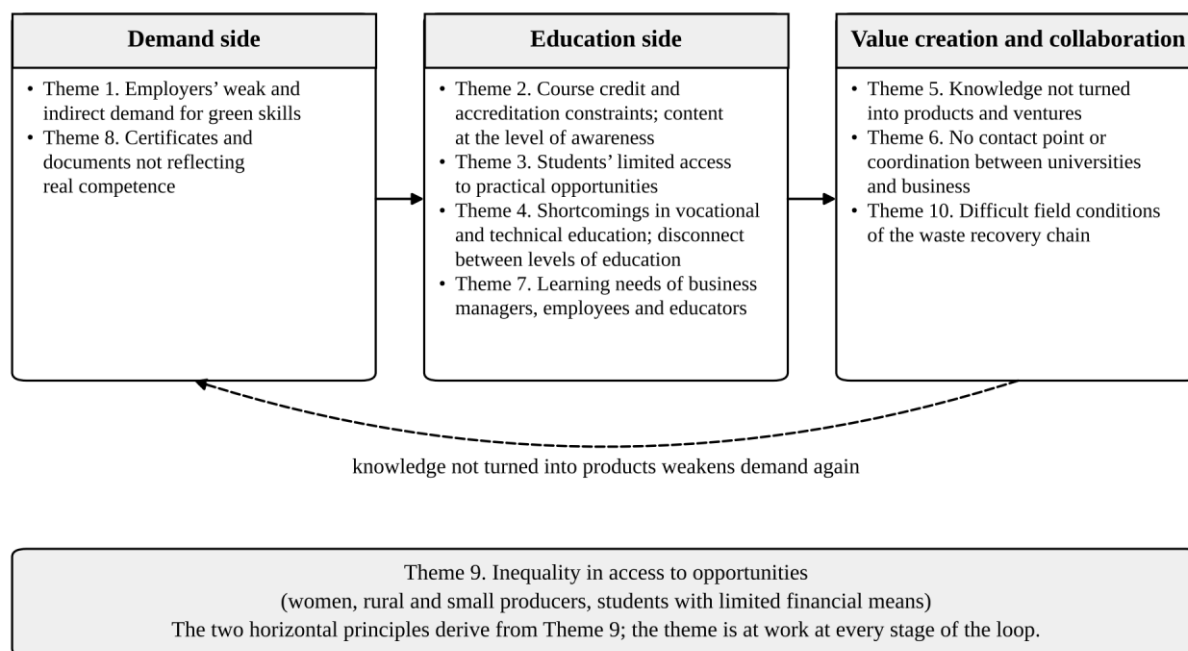


Figure 6. Relationships between the Themes

Note: Arrows show the direction of influence as interpreted by the report team; the dashed arrow shows the feedback relationship that closes the loop.

Figure 6 depicts a cycle in which the weakness of employer demand limits education institutions' motivation to change, shortcomings in education make it harder for knowledge to be turned into products, and knowledge that is not turned into products weakens demand once again; inequality of opportunity (Theme 9) is at work at every stage of this cycle, and the two horizontal principles in Section 6 derive from this theme. These relationships are cause-and-effect links constructed by the authors on the basis of participants' statements. The themes are discussed in turn below.

Theme 1. Employers' Weak and Indirect Demand for Green Skills

Businesses turn to the green transition mostly because of the demands of customers in export markets, EU regulations, the conditions banks set when lending, and legal obligations (Roundtables 1, 2, 3, 4 and 7). Green awareness is not sought in recruitment; willingness and openness to learning come to the fore (Roundtables 1, 4 and 5). Compliance achieved under these external obligations often remains at the level of documents, reports and labels (Roundtables 1, 4 and 7). Employment conditions such as engineers being employed in jobs that do not match their abilities (underemployment) and low pay also weaken demand for green skills (Roundtables 2 and 5).

Theme 2. Course Credit and Accreditation Constraints and Course Content That Remains at the Level of Awareness

Course credit limits, programme accreditation rules and faculty members' resistance to change leave no room for adding new content to courses (Roundtable 1); even where sustainability is added to the intended learning outcomes of programmes, this content is not reflected in examinations (Roundtable 4). Existing course content is limited to introducing the subject; it does not include measurement and calculation related to the green transition, or practice in a business environment (Roundtables 1, 2, 3, 4 and 5). Graduates were said not to have a

command of food legislation and waste regulations (Roundtables 2 and 5). As a solution, adding content to existing courses rather than creating separate programmes, and spreading project-based work across all courses, were proposed (Roundtables 4 and 6).

Theme 3. Students' Limited Access to Practical Opportunities

Students' access to fieldwork, real data and up-to-date teaching materials is limited. The difficulty of finding internship places, the burden of insurance, occupational safety and costs, and internships documented without actually being carried out were noted (Roundtables 1, 2 and 3). The inadequate equipment of university laboratories, lengthy equipment procurement and gaps in computing infrastructure narrow the practical opportunities available on campus (Roundtables 2 and 3). Students were said to have insufficient contact with businesses; trade fairs, company visits and a six-month practical period were proposed (Roundtable 5).

Theme 4. Shortcomings in Vocational and Technical Education and the Disconnect between Levels of Education

Vocational and technical education was addressed directly at two roundtables. It was stated that graduates' knowledge of materials and production is weak, that apprenticeships can be run without supervision and that vocational and technical education institutions cannot find suitable businesses in which their students can gain practical experience (Roundtable 1). It was emphasised that students with relatively lower academic achievement are placed in vocational and technical education institutions, yet that these students have the chance to gain practical experience by taking part in production processes (Roundtable 6). It was stated that STEM activities in primary and secondary education lack support and that their intended learning outcomes are not clearly defined (Roundtables 1 and 3), and that the working habits acquired at school are not maintained at university in the absence of grades or compulsion (Roundtable 5).

Theme 5. Knowledge Not Being Turned into Products and Ventures

The intermediate steps required for the outputs of research and education to be turned into products or ventures (prototype, market analysis, protection of intellectual property rights, industrial partner) are missing. Skills in presenting a business idea, prototyping, markets, accounting and marketing are weak (Roundtables 2, 4, 5 and 7). Intellectual property rights and shares of contribution are not determined in advance (Roundtables 2 and 6). The development of project ideas without regard to legislation and the uncertainty of labelling rules were also assessed under this theme (Roundtables 4 and 5). An example was given of a product developed at the university that could be put into serial production and developed into a brand only with an industrial partner (Roundtable 3). An example was also given of a student who had the idea of developing a product from waste but did not pursue it for fear of finding no support, so that the idea went no further (Roundtable 1).

Theme 6. Lack of a Contact Point and Coordination between Universities and Business

There is no authorised and permanent unit (contact point) to establish relations between education institutions and businesses, public institutions and civil society organisations, and to which requests can be directed (Roundtables 1, 2, 3, 6 and 7). Producers not knowing whom to approach at the university, relations running on personal acquaintance, the fragmentation of support and a lack of awareness of the opportunities offered by technoparks are the main

manifestations of this gap. A lack of coordination between ministries and the application of different rules to the same waste were also given as examples (Roundtables 2 and 6). The solutions proposed by participants are an advisory unit at the university, matching platforms that bring businesses and students together, and innovation centres.

Theme 7. The Learning Needs of Business Managers, Employees and Educators

The green transition requires not only students but also business managers, employees and educators to learn. Management not taking ownership of the process and employee resistance (Roundtables 1 and 4), training remaining a one-off exercise (Roundtable 1) and businesses' limited interest in training programmes (Roundtable 5) are the prominent findings. Educators applying methods incorrectly or insisting on traditional methods (Roundtables 3 and 6), new content not spreading across all subject areas (Roundtable 1) and the need for training in assessment and evaluation (Roundtable 6) were noted. It was also stated that businesses are aware of the obligations brought by EU regulations but do not know what they need to do (Roundtable 2), and that women entrepreneurs need accounting, invoicing and digital skills while the effects of the training provided are not monitored (Roundtable 7).

Theme 8. Certificates and Documents Not Reflecting Real Competence

The certificates and documents that students obtain by attending various training courses were said not to reflect real competence: candidates holding an environmental management system certificate did not have a command of its content (Roundtable 1), certificates of attendance merely increased the number of participants (Roundtable 2) and internships that were never actually carried out were documented (Roundtable 3). Employers attach more weight to project, club and communication experience (Roundtable 1) and to references and corporate experience (Roundtable 5) than to grade point averages. Short certificate programmes were said to benefit graduates (Roundtable 4); documents showing duration, workload and the equivalent in course credit were proposed (Roundtable 6).

Theme 9. Inequality in Access to Opportunities

Women face a care burden, a social perception that women cannot run commercial activities, male-dominated industry and business networks, and a lack of representation on decision-making bodies (Roundtables 1 and 7); the male-dominated composition of engineering departments was also mentioned (Roundtable 2). Differing views were also put forward on this issue: it was stated that no discrimination is observed in recruitment (Roundtable 1) and that difficulty in accessing finance is not specific to women (Roundtable 7). Rural and small producers have difficulty accessing information and the university (Roundtables 3, 5 and 7); students cannot meet the costs of internships, transport and teamwork (Roundtables 2 and 3). It was also noted that gender equality should be observed as a dimension of sustainability and that one student had had to pay for a sustainability course out of their own pocket, in instalments (Roundtable 4).

Theme 10. The Difficult Field Conditions of the Waste Recovery Chain

Waste is not separated at source, or separately collected waste is mixed again (Roundtables 1, 3, 5 and 7). There are failures in deposit return and collection systems (Roundtables 1 and 3); industrial treatment sludge also poses a problem (Roundtable 2). Collecting, transporting and storing agricultural waste is difficult (Roundtable 3). The measurement of waste is uncertain

and reliable data are limited (Roundtables 3, 4 and 5); there is a gap between legislation and practice (Roundtables 2, 3 and 5). Under these conditions, obtaining products from waste requires knowledge of measurement, logistics, legislation and economics in addition to technical knowledge (Roundtable 3). The challenges derived from the themes are addressed in the following section.

5. Challenges, Expectations and Points of Disagreement

5.1 Nineteen Challenges

On the basis of the themes, nineteen concrete challenges raised at two or more roundtables were identified. The challenges are grouped at four levels: conditions in education, difficulties observed in students, employer demand and employment conditions, and institutional and structural barriers. Figure 7 shows these four levels and the challenges at each level.

Conditions in education 8 challenges • Course credit and accreditation rules leaving no room for new content • Course content remaining at the level of awareness • Lack of internship places and poor-quality internships • Inadequate equipment in university laboratories • Inadequate practical training in vocational and technical education • STEM activities not developed into projects and left unsupported • Educators' lack of knowledge of teaching methods and assessment • Certificates and documents not reflecting real skills	Difficulties observed in students 2 challenges • Weak legislative literacy (lack of command of regulations and communiqués) • Lack of knowledge of presenting a business idea, prototyping, costing, markets and accounting
Employer demand and employment conditions 4 challenges • Green skills not being a recruitment criterion • Compliance with the green transition only on paper, driven by customer, EU and bank obligations • Engineers employed in jobs that do not match their abilities (underemployment) • Management not taking ownership and one-off employee training	Institutional and structural barriers 5 challenges • Intellectual property rights and sharing rules not set in advance in student projects • No contact point between universities and business, and weak coordination • Barriers faced by women entrepreneurs and employees (care burden, male-dominated networks, lack of representation) • Access difficulties of rural and small producers; students unable to meet internship and transport costs • Field conditions of the waste recovery chain (separation, transport, measurement, data)

Figure 7. The Four Levels of Challenges

The four boxes in Figure 7 represent the four levels at which the challenges are grouped; the numbers in the boxes are the number of challenges at each level. No ranking or order of priority is implied between the levels. Eight of the challenges concern conditions in education, two the difficulties observed in students, four employer demand and employment conditions, and five institutional and structural barriers. This distribution is important in showing that most of the problems raised at the workshop concern not students' individual shortcomings but the institutional conditions in which students are educated. Statements about students reflect

participants' observations; student competences were not measured. The full list of challenges and their distribution across roundtables is given in Table 9.

Table 9. The Nineteen Challenges and Their Distribution across Roundtables

Level	Challenge	Roundtables
Conditions in education	Course credit load and programme accreditation leaving no room for adding new content to courses	1, 4
Conditions in education	Course content remaining at the level of awareness; measurement and calculation related to the green transition not being taught	1, 2, 3, 4, 5
Conditions in education	Lack of internship places and the low quality of internships	1, 2, 3
Conditions in education	Inadequate equipment in university laboratories	2, 3
Conditions in education	Inadequate practical training in vocational and technical education institutions and the placement in these institutions of students with relatively low academic achievement	1, 6
Conditions in education	STEM activities not being developed into projects and remaining unsupported	1, 3, 5
Conditions in education	Educators' inadequate knowledge of teaching methods and of assessment and evaluation	1, 3, 6
Conditions in education	Certificates and internship documents not reflecting real skills	1, 2, 3, 6
Difficulties observed in students	Weak legislative literacy: lack of command of regulations and communiqués	2, 3, 4, 5
Difficulties observed in students	Lack of knowledge of presenting a business idea, prototyping, costing, markets and accounting	2, 4, 5, 7
Employer demand and employment conditions	Green skills not being a recruitment criterion	1, 4, 5
Employer demand and employment conditions	Compliance with the green transition only at the level of documents, driven by obligations imposed by customers in export markets, EU regulations and banks	1, 2, 3, 4, 7
Employer demand and employment conditions	Engineers being employed in jobs that do not match their abilities (underemployment)	2, 5
Employer demand and employment conditions	Business management not taking ownership of the green transition and employee training remaining a one-off exercise	1, 4, 5
Institutional and structural barriers	Intellectual property rights and rules on sharing not being determined in advance in student projects	2, 6

Level	Challenge	Roundtables
Institutional and structural barriers	Lack of a contact point between universities and business and weak coordination between institutions	1, 2, 3, 6, 7
Institutional and structural barriers	Barriers faced by women entrepreneurs and employees: care burden, social perceptions, male-dominated business networks and lack of representation on decision-making bodies	1, 2, 7
Institutional and structural barriers	Difficulties of rural and small producers in accessing information and the university, and students' inability to meet internship and transport costs	2, 3, 5, 7
Institutional and structural barriers	Field conditions of the waste recovery chain: the separation, collection and transport of waste, its measurement and data	1, 2, 3, 4, 5, 7

According to Table 9, the challenge raised at the most roundtables on the employer side is that businesses comply with the green transition only because of external obligations and only at the level of documents; green skills not becoming a recruitment criterion is related to this. On the education side, course credit load, content that remains at the level of awareness and the lack of internship places reinforce one another: when the curriculum cannot make room for new content, measurement and calculation skills cannot be taught, and when no internship is available, this gap cannot be closed in a business environment either. The difficulties observed in students should be regarded as a consequence of these conditions; indeed, the same participants also stated that curricula do not include these skills. The lack of a contact point between universities and business was expressed in different forms at five roundtables. The relationship between the challenges and the expectations of business is addressed in the following subsection.

5.2 Business Expectations and Reported Difficulties

Table 10 compares the skills that business representatives expect of graduates with the difficulties reported by participants.

Table 10. Business Expectations and Reported Difficulties

Business expectation	Reported difficulty	Roundtables
Willingness and openness to learning	Regarded as the basic criterion in recruitment. One employer representative criticised graduates' salary expectations but stated that employers, too, must reciprocate.	1, 5
Rapid adaptation to the job	It was stated that new graduates cannot be employed without additional training and that they learn the legislation and the job in the business.	2, 5
Knowledge of materials and production processes	Graduates of vocational and technical education institutions and of universities were said to start work without experience of materials and production, with basic knowledge having to be taught again in the business.	1
Experience in a business environment	Students were said to have no knowledge of the business environment or of waste types and insufficient contact with businesses; internship places cannot be found, or internships are not actually carried out.	1, 2, 3, 5
Calculation, measurement and monitoring	Calculation along the production chain and the measurement of carbon, energy and waste data are not included in curricula.	1, 4
Interpreting data and seeing the whole picture	Sustainability reporting is reduced to a single branch of engineering or to calculations based solely on invoices, and the interpretation of data remains weak.	4
Skills that combine different fields	It was stated that sustainability reporting can be carried out by people with strong analytical and communication skills, and that every graduate needs to be open to innovation and able to adapt new tools to their own field.	4
Knowledge of legislation and standards	Graduates were said not to have a command of the legislation on environmental sustainability and to acquire this knowledge in the business.	2, 5
Presenting a business idea and communication	Skills in presenting ideas, persuasion, marketing, accounting and business management were said to be weak, and academic education to be confined to the technical dimension.	2, 4
Questioning and establishing cause-and-effect relationships	Students were said to apply what they are taught without questioning it and to have difficulty integrating their ideas and establishing cause-and-effect relationships.	1, 2, 6
Project, club and communication experience	It was stated that project, club and communication experience counts for more than grade point averages in recruitment, and that this experience is not reflected in existing documents.	1, 6

Business expectation	Reported difficulty	Roundtables
Demand for green skills (employer side)	It was stated that green awareness is not sought in recruitment and that job advertisements for sustainability reporting expertise have appeared only recently.	1, 4

The last row of Table 10 shows that the gap is not only on the education side: employers do not yet regard green skills as among the core competences they look for in recruitment. Business expects both general attitudes such as willingness and job-specific skills such as knowledge of measurement, legislation and the business environment, but does not state these expectations explicitly in job advertisements or internship descriptions. Education institutions, in turn, do not reflect this unstated expectation in their curricula. Alongside participants' common tendencies, the issues on which they disagreed are presented in the following subsection.

5.3 Issues on Which Participants Disagreed

Although the themes reflect common patterns, participants put forward differing views on a number of issues. Table 11 shows these disagreements.

Table 11. Marked Disagreements at the Roundtables

Issue	One view	Opposing or differing view	Roundtable
Where green skills should be acquired	Technical gaps can be filled on the job in the sector; education institutions should focus on social skills.	Teaching on the job would come too late; the conceptual foundation should be laid at school, together with practice.	1
Gender equality	Associating certain occupations with women is an inequality.	No gender-based discrimination is observed in recruitment; what matters is awareness and skill.	1
Access to the university's laboratory and equipment inventory	The tests carried out by the university's central laboratory and their fees are published online; firms that know of this apply.	Feedback from firms indicates that this facility is not known and that there is a disconnect between the university and industry.	2
The form of practical training	The final semester should be spent in a business; students should gain long-term work experience in industry.	Current internship practices are dysfunctional; practice should be built into the curriculum.	3
The link between the university and producers	Businesses can approach the university to request students.	Producers do not know whom to contact; establishing the link is the university's responsibility.	3

Issue	One view	Opposing or differing view	Roundtable
Who should carry out sustainability reporting	Data can be provided by all units; the reporting framework should be established by engineers, primarily environmental engineers.	Sustainability reporting is not the preserve of any single profession; what matters is the ability to see the whole picture and to interpret data.	4
The importance customers attach to the sustainability report	Customers primarily assess the product and its price; a green product is preferred only when other conditions are equal.	Banks and corporate customers have begun to request sustainability reports and scores.	4
Supporting small producers	Farmers can be trained at public education centres and set up their own ventures.	Cooperative management is traditional in structure; the focus should be on ventures with added value and demand.	5
Access to finance	Access to finance is the main problem of women entrepreneurs.	Access to finance is a common problem regardless of the entrepreneur's gender.	7
The source of support for women entrepreneurs	Support and project development should be carried out by the state.	The state should act as a facilitator; a venture capital fund should be set up with the participation of business people in the region.	7
Directing women entrepreneurs to networks in major cities	Women with potential should be connected with entrepreneurship networks in major cities.	Childcare, marriage and transport conditions make this difficult; there are also many women with potential locally.	7

The disagreements in Table 11 fall into three clusters: the place and form of practical training, access to university infrastructure and who should establish the university-producer link (Roundtables 1, 2 and 3); who should carry out sustainability reporting and the importance customers attach to the report (Roundtable 4); and how small producers and women entrepreneurs should be supported (Roundtables 5 and 7). These disagreements are not presented as common views; they are reported in order to identify the options that remain open to debate in subsequent work. The development needs derived from the challenges are addressed in the following section.

6. Development Needs

The arrangement or resource required to overcome each challenge was defined as a development need; fifteen development needs were thus identified. The two issues under

inequality in access to opportunities (Theme 9), namely women’s access to opportunities in green STEM and green entrepreneurship, and the access of rural and small producers together with the financial barriers faced by students, are not problems that can be met by a single need; they emerged at several roundtables and at all levels. These two issues have therefore been set apart as horizontal principles to be observed in implementing all the other needs. Figure 8 shows the needs in three groups according to the means by which they can be met, and the horizontal principles in a separate area.

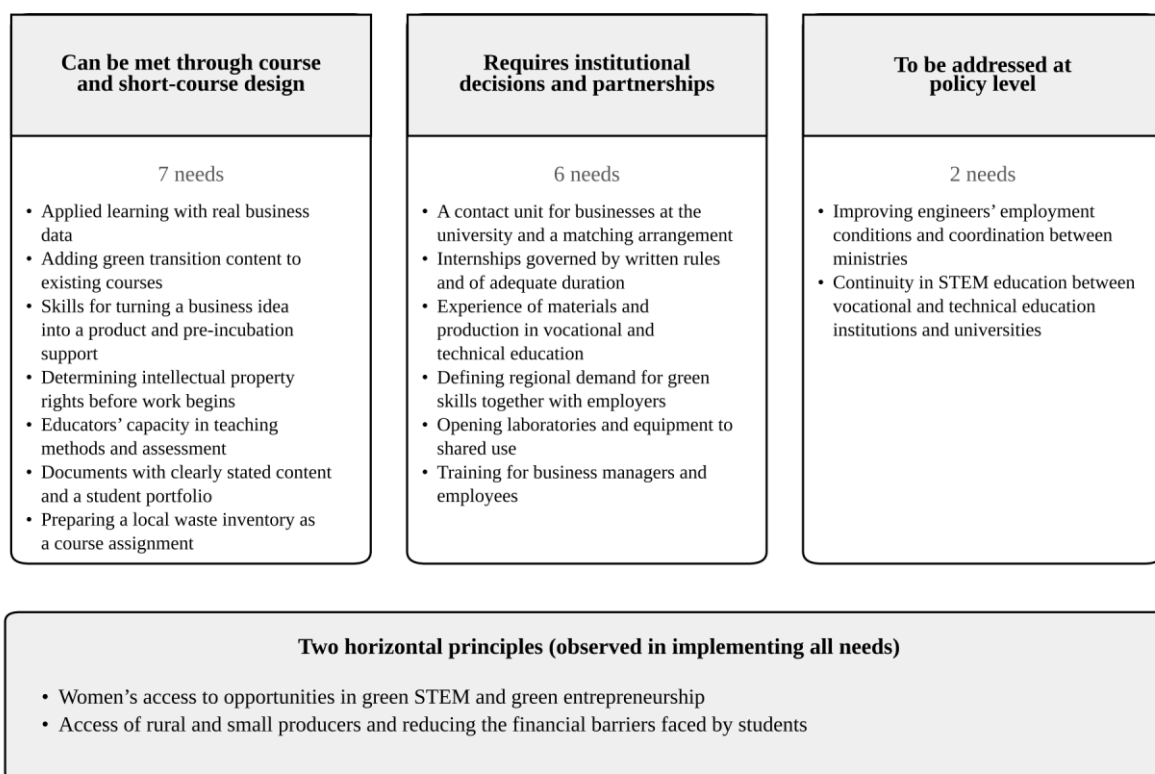


Figure 8. The Fifteen Needs and the Two Horizontal Principles: Ways of Meeting Them

According to Figure 8, seven needs can be met through course and short-course design; six require universities, businesses and public institutions to take joint decisions or form partnerships; and two need to be addressed at policy level. This grouping shows the primary means for each need, not an order of importance; a need may be supported in more than one way. The two horizontal principles at the bottom of the figure are not a separate group; they express conditions to be observed in implementing all the needs. Table 12 lists the needs by these groups and shows, for each, the finding on which it rests and the proposed action; the horizontal principles appear in the last two rows of the table.

Table 12. Development Needs and the Findings on Which They Rest

Development need	Underlying finding	Proposal
Adding green transition content to existing courses in the form of short learning units with measurable outcomes	Course credit load and programme accreditation leave no room for adding new content to courses; course content remains at the level of awareness.	Departments should place short learning units on green transition topics (blocks of a few weeks with measurable outcomes) within existing courses. These units should be written into course information packages (the official description of course content) and into examination content.
Applied learning with real business data: calculation, measurement, knowledge of legislation and monitoring the production process as a whole	Measurement and calculation related to the green transition are not taught; graduates lack a command of the relevant legislation and are unfamiliar with the business environment.	Universities and businesses should prepare project assignments in which students work with real carbon, energy, waste and cost data obtained from businesses and apply the relevant legislation. Outputs should be assessed against predetermined criteria.
Skills for turning a business idea into a product and pre-incubation support for student ventures	Skills in presenting ideas, prototyping, markets and accounting are weak; research outputs are not evaluated as products.	Departments should add to their courses a project component that includes presenting a business idea, prototyping, costing and market analysis; student teams should present their ideas to business representatives at the end of the semester. Ideas with potential for development should be matched with a mentor through incubation centres.
Determining intellectual property rights, confidentiality and shares of contribution in writing before work on student projects begins	Shares of contribution and rights are not put in writing; ideas can be used by others.	The university should prepare a standard contract template governing intellectual property rights, confidentiality and shares of contribution in student projects. The template should be signed at the start of each project by the student, the supervisor and, where applicable, the business.
Developing educators' capacity in teaching methods and in assessment and evaluation	Peer assessment does not yield reliable results; teaching methods are applied incorrectly, or traditional methods are insisted on.	The university and the Sakarya Directorate of Education should organise applied training for educators on project-based teaching and the assessment of teamwork. The outcome-based scales developed in the training should be trialled in participants' own courses.

Development need	Underlying finding	Proposal
Training documents with clearly stated content and a student portfolio	Certificates, attendance documents and internship documents do not reflect skills.	Institutions providing short training courses should design their documents to show the aim, duration, learning outcomes, assessment activities and course credit equivalent of the training. Students should keep a project portfolio that can be shared with employers and attached to the document.
Local inventory of waste and by-products, measurement, preliminary feasibility and the value accruing to producers	Collection, transport, measurement and data conditions are unknown; the value created does not reach the producer.	The university, together with municipalities and cooperatives, should launch, as a student course assignment, an inventory recording the quantity, seasonality and collection conditions of agricultural waste and by-products in the region. Preliminary feasibility reports based on the inventory should be shared with producers.
A contact unit for businesses and producers at the university, a matching arrangement and an up-to-date inventory of facilities	Producers and businesses cannot find a counterpart at the university; support remains fragmented.	The university should designate a single contact unit to which businesses and producers can turn and publicise it through the chambers of commerce and industry and the regional development agency. Using an up-to-date inventory of laboratories, equipment and expertise, the unit should direct requests to the relevant departments.
Internships governed by written rules, of adequate duration and under supervision	Internship places cannot be found; the burden of insurance, occupational safety and costs deters businesses; internships that are never carried out are documented.	The university and businesses should prepare a written internship protocol governing the duration of the internship, its learning objectives, the supervisor's duties, insurance and occupational safety obligations, and cost sharing. Internships should be assessed on the basis of the outputs the student produces in the business.
Experience of materials and production in vocational and technical education institutions, supervised workplace learning and STEM teacher development	Graduates' knowledge of materials is weak; apprenticeships are unsupervised; vocational and technical education institutions cannot find businesses in which their students can gain practical experience.	The Sakarya Directorate of Education, vocational and technical education institutions and businesses should jointly plan and monitor workshop and in-company practice in which students work with materials and production processes. Industry-linked refresher training should be organised for STEM teachers.

Development need	Underlying finding	Proposal
Defining and monitoring regional demand for green skills together with employers	Employers do not define green skills; demand arises from external obligations imposed by customers and regulations.	The chambers of commerce and industry and the regional development agency, together with the university, should prepare a regularly updated list of the skills that businesses need for the green transition. The list should be used in job advertisements and internship descriptions, and curricula should be reviewed accordingly.
Laboratory, equipment and computing infrastructure open to shared use	Infrastructure in university laboratories remains inadequate because of budget constraints.	The university should establish an arrangement that opens its laboratory and equipment inventory to businesses and student teams, and conclude shared-use agreements with businesses. In fields where equipment procurement takes a long time, practical work should be carried out at businesses' production facilities.
Role-specific, regularly repeated training for business managers and employees	Unless business management takes ownership, green transition efforts remain on paper; employee training is not repeated.	The university's continuing education centre, the chambers of commerce and industry and businesses should prepare short training modules with separate content for senior management, middle managers and employees. The training should be repeated at regular intervals and include a component that monitors implementation in the business.
Continuity in STEM education between vocational and technical education institutions and universities	STEM activities in education institutions lack support; learning outcomes are vaguely defined; there is no continuity in the transition between levels of education.	The Sakarya Directorate of Education and the universities should prepare a transition framework linking the learning outcomes of STEM activities to vocational and technical education and university programmes. STEM activities should be given materials and advisory support, and their learning outcomes should be written in measurable form.
Improving engineers' employment conditions and coordination between ministries	Engineers being employed in jobs that do not match their abilities (underemployment), the gap between legislation and practice, and the lack of coordination between ministries.	The project partners and the university should prepare a policy brief documenting, with concrete examples, the employment of engineers in jobs that do not match their abilities and at low pay, and the application of different rules to the same waste. The brief should be shared with the relevant ministries and chambers in order to secure coordination between ministries.

Development need	Underlying finding	Proposal
Women's access to opportunities in green STEM and green entrepreneurship (horizontal principle)	Women's care burden, male-dominated business networks and lack of representation on decision-making bodies.	The project partners should monitor the proportion of women participants and mentors in all training and support activities, and plan the venue, timing and childcare arrangements of activities so as to facilitate women's participation. Matching events that bring women entrepreneurs together with industry networks should be organised.
Access of rural and small producers and reducing the financial barriers faced by students (horizontal principle)	The formal language of institutions alienates rural women; students cannot meet internship and transport costs.	The university and the project partners should prepare training and information materials for producers in plain language and deliver them locally through public education centres and cooperatives. Support options for students' internship, transport and project material costs should be identified together with businesses and the chambers of commerce and industry.

The seven needs in Table 12 that can be met through course and short-course design constitute the starting point for the next step of the GreenSTEM project, the design of the education programme. The six needs that require institutional decisions and partnerships call for the involvement not only of universities but also of businesses, the Sakarya Directorate of Education, the chambers of commerce and industry, the regional development agency and municipalities. The project's contribution to the two needs at policy level will be limited to developing policy proposals and consulting the relevant stakeholders. It should not be concluded that the needs raised at a small number of roundtables (vocational and technical education institutions, intellectual property rights, infrastructure) are less important; the number of roundtables indicates how widespread a topic was in the discussions, not its importance.

Conclusion

The Pre-COP31 Workshop was organised to identify the challenges encountered in aligning STEM education in universities and vocational and technical upper secondary institutions with the demands of the market and of business, and to determine development needs on the basis of these challenges. The thematic analysis of the transcripts of the seven thematic roundtables answers this aim at two levels: the ten common themes and the nineteen challenges derived from them define where and how the mismatch arises, while the fifteen development needs and the two horizontal principles define the means by which it can be addressed. The central conclusion to emerge from the findings as a whole is that the gap between STEM education and the skills needs of the green transition cannot be explained by the shortcomings of one side alone. The gap stems from a self-reinforcing cycle in which employers' demand for green skills remains weak and indirect, course content in education institutions fails to move beyond the level of awareness, and the knowledge produced is not turned into products or ventures; inequality in access to opportunities makes itself felt at every link of this cycle.

On the labour demand side, the most striking finding of the workshop is that business people do not yet regard alignment with the green transition as a priority objective. Employers do not widely seek green skills in recruitment and give prominence instead to general attitudes such as willingness and openness to learning. The factors that drive businesses towards the green transition are external obligations such as the expectations of customers in export markets, European Union regulations and the conditions banks set when lending; compliance with these obligations, in turn, often remains at the level of documents, reports and labels. The employment of engineers in jobs that do not match their abilities and at low pay is also among the employment conditions that weaken demand for green skills in STEM fields. This picture indicates that education institutions cannot achieve alignment merely by responding to existing demand. Defining and monitoring regional demand for green skills together with employers is therefore not merely one of the needs listed in the report but a precondition that gives the other needs their meaning.

On the education side, the challenges are concentrated not in students' individual shortcomings but in the institutional conditions in which students are educated. Only two of the nineteen challenges concern difficulties observed in students, whereas eight concern conditions in education, four employer demand and employment conditions, and five institutional and structural barriers. Course credit limits and programme accreditation rules leave no room for adding new content to courses; existing content is limited to introducing the subject; and measurement and calculation related to the green transition, knowledge of legislation and experience in a business environment find no place in curricula. The lack of internship places, internships documented without actually being carried out and inadequately equipped laboratories also prevent this gap from being closed in practical settings. The weakness of production experience in vocational and technical education institutions and the disconnect between levels of education show that the problem is not confined to higher education. The difficulties that participants observed in graduates (a lack of command of legislation, an inability to present a business idea, a lack of cost and market knowledge) are the consequence of these conditions; indeed, the same participants also stated that curricula do not include these skills.

The third conclusion of the workshop concerns the lack of institutional mechanisms to connect the two sides of alignment. Because producers and businesses do not know whom to approach at the university, relations run on personal acquaintance and support remains scattered across institutions, the intermediate steps required to turn knowledge into products (prototype, market analysis, protection of intellectual property rights, industrial partner) cannot be taken. The two themes that emerged at all seven roundtables, knowledge not being turned into products and ventures and the learning needs of business managers, employees and educators, show that alignment is not merely an educational problem concerning students; business management, employees and educators are also learning parties in the same process. The field conditions of the waste recovery chain, for their part, demonstrate concretely that technical knowledge alone is not enough and that knowledge of measurement, logistics, legislation and economics is required alongside it.

These conclusions set a clear direction for the education design of the GreenSTEM project. The seven needs that can be met through course and short-course design point to adding short

learning units with measurable outcomes to existing courses; conducting learning with real carbon, energy, waste and cost data obtained from businesses and by applying the relevant legislation; making skills for turning a business idea into a product, along with written arrangements on intellectual property rights, part of course content; strengthening educators' capacity in teaching methods and assessment; designing documents and portfolios so that they show the skills acquired; and preparing an inventory of the region's waste and by-products as a student course assignment. The common denominator of these units is the integration of new content into existing courses, work with real data and assessment based on outputs. The six needs that require institutional decisions and partnerships call for the involvement not only of universities but also of businesses, the Sakarya Directorate of Education, the chambers of commerce and industry, the regional development agency and municipalities, while the project's contribution to the two needs at policy level is limited to developing policy proposals and consulting the relevant stakeholders. Women's access to opportunities in green STEM and green entrepreneurship, and the access of rural and small producers together with reducing the financial barriers faced by students, are the two horizontal principles to be observed throughout all of this work.

The framework presented in the report rests on the views expressed at the seven roundtables and shows how widespread a topic was across roundtables; accordingly, it does not express consensus among participants. For this reason, the needs that emerged at a small number of roundtables (vocational and technical education institutions, intellectual property rights, infrastructure) should not be regarded as less important. The issues on which participants disagreed, namely whether practical training should be provided in education institutions or in businesses, who should establish the link between the university and producers, who should carry out sustainability reporting, and how small producers and women entrepreneurs should be supported, are not presented as common views. Held in Türkiye in the run-up to COP31, this workshop indicates that the skills dimension of the green transition requires employers, education institutions and public institutions to move simultaneously; the ten themes, nineteen challenges, fifteen needs and two horizontal principles offer the GreenSTEM project and its partners a common language and a starting point for designing that movement.

References

- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp0630a>
- Braun, V., & Clarke, V. (2022). *Thematic analysis: A practical guide*. SAGE.
- Regulation (EU) 2021/1060 of the European Parliament and of the Council, 2021 O.J. (L 231) 159. <http://data.europa.eu/eli/reg/2021/1060/oj>
- United Nations Framework Convention on Climate Change. (2026). *UN Climate Change Conference - Antalya* [Overview schedule, version dated 7 October 2026]. https://unfccc.int/sites/default/files/resource/COP_31_Overview_Schedule.pdf



