



Transdisciplinary Research and Education for Sustainable Development

Report on a workshop for Central Asian Experts in Bishkek,
Kyrgyzstan on 16-19 June 2025

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Introduction

Universities worldwide, including those in Central Asia and Europe, are facing new tasks and challenges. In Central Asia new tasks emerge in the context of reforms currently ongoing in the countries of the region. Kazakhstan, Kyrgyzstan, and Uzbekistan are pursuing ambitious reforms to modernise their economies, diversify industries and create new opportunities for employment and entrepreneurship. Similar goals shape development strategies in Europe. New challenges arise from rapid changes such as AI and automation as well as shifting global markets. They also stem from the complex 'grand challenges' of our time, such as climate change, urbanisation and social cohesion.

Addressing these new tasks and complex challenges, requires not only technological solutions but also new forms of interaction between sectors and disciplines. Challenges of this scale rarely fit neatly within the boundaries of a single discipline or institution. Instead, they call for approaches that combine scientific expertise with practical knowledge from industry, government and society.

Transdisciplinary research and education offer a framework, methods and tools for universities to play a crucial role in these transformations. As institutions that generate knowledge and educate future professionals, they contribute directly to education, innovation and economic development. Transdisciplinary approaches aim to bring together different forms of knowledge and different societal actors to address complex challenges. Researchers collaborate with practitioners, policy makers, businesses and communities to jointly analyse problems and develop solutions. Transdisciplinary research is not a substitute or alternative but rather a complement to disciplinary approaches and research methods, for example in engineering or social sciences.

Current national strategies in Kazakhstan, Uzbekistan, and Kyrgyzstan also emphasise closer links between universities, research, industry, and society. Development programmes such as the Kazakhstan Strategy 2050, Uzbekistan's higher education reforms, and the National Development Programme of the Kyrgyz Republic until 2026 all highlight the need to modernise universities, strengthen applied research, and connect education more closely with innovation and labour market needs.



Workshop participants from Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan and Germany in Bishkek, June 2025. Photo by OSCE Academy in Bishkek

In June 2025, the SPCE Hub Network, the Intersectoral School of Governance BW, and the OSCE Academy in Bishkek organised a 3.5-day workshop on transdisciplinary education and research in partnership with Technische Universität Berlin and Hochschule Karlsruhe. It discussed the potential of these fields for higher education, research and sustainable development in Central Asia. Twenty-one senior academics and professors from Central Asia took part in the workshop. Three experts in transdisciplinary education and research from Germany provided scientific and methodological input. The workshop was financed by the German Academic Exchange Service with funds from the German Federal Foreign office.

This report aims to inform the professional community about the content and discussions of the workshop. The following two sections provide an introduction to transdisciplinary university education and research. This is followed by four project ideas developed during a workshop exercise, which demonstrate the structure and potential of transdisciplinary projects in the region. The final section presents innovative teaching projects in Central Asia, demonstrating that the concept of transdisciplinarity is already being applied.

Dr. Sebastian Schiek, Dr. Kishimjan Osmonova
SPCE Hub Network

1. Transdisciplinary Education

By PD Dr. Thorsten Philipp, Technische Universität Berlin

Transdisciplinary education offers a strategic response to current interrelated and often complex goals of universities. It connects academic learning closely with societal needs, economic transformation and sustainable development. Rather than operating at a distance, universities become actively involved partners in innovation ecosystems.

At the core of transdisciplinary education is the recognition that valuable knowledge exists in multiple forms. Scientific expertise remains essential, but it is complemented by professional experience, entrepreneurial practice, technical know-how and local knowledge. When these different perspectives are brought together, solutions become more realistic, inclusive and sustainable.

This also broadens the circle of those who contribute to knowledge creation. Students, researchers, professionals, entrepreneurs, public institutions and citizens may all play a role. In practice, the shift to transdisciplinary learning can take many forms that share a commitment to joint problem-solving in real contexts. Universities may develop real-life laboratories where new solutions are tested, organise hackathons or community-based learning initiatives, or integrate mentored internships with defined learning goals into degree programmes.

For labour market development, this model has many advantages. Knowledge economies require graduates who are not only technically competent, but also able to work in different sectors, manage uncertainty, communicate effectively and act responsibly. Transdisciplinary education creates opportunities for students to develop these competencies during their studies.

Embedded internships are a major example. Unlike short, informal placements, these internships are integrated into academic programmes and combined with systematic reflection. Students spend extended periods in professional environments and apply theoretical knowledge to concrete challenges. This strengthens employability, builds professional networks and fosters a deeper understanding of economic and social realities.

Entrepreneurship education provides another example. It is broadly understood as the ability to transform ideas into value for others. This value may be economic, social, cultural, or ecological.

Students learn to work in teams, to respond creatively to uncertainty and to engage with external partners. Such programmes can integrate sustainability, ethical reflection and social responsibility. In doing so, they prepare graduates not only to compete in markets, but also to contribute to sustainable development and inclusive growth. For middle-income countries seeking to stimulate small and medium-sized enterprises, start-up ecosystems and innovation-driven growth, this form of education can support job creation and economic diversification.

A central competence in transdisciplinary collaboration is communication. Participants must be able to engage with people from different disciplinary backgrounds, professional cultures and social contexts. This requires the ability to translate concepts between different knowledge traditions, to listen carefully to new perspectives and approaches and to develop practices of feedback literacy that allow reflective dialogue and mutual learning.

Implementing transdisciplinary education can be challenging. Universities, traditionally organised around disciplines, hierarchies and procedures, need flexible structures, strong partnerships with external actors and incentive systems that reward collaboration and experimentation. Participation, reflection and feedback become essential components of learning. Setbacks are understood as opportunities for improvement, not merely as failures.

For policy makers, supporting transdisciplinary education can align higher education more closely with sustainable development strategies, labour market needs and innovation policies. For universities, it enhances societal relevance and international competitiveness. For students, it offers skills and experiences that increase employability and prepare them for responsible leadership in evolving economies.

Transdisciplinary education is therefore more than a teaching method. It is a strategic framework for connecting knowledge production with economic transformation and sustainable development. By bringing together diverse forms of expertise and embedding learning in societal contexts, universities strengthen their role as motors of innovative growth, inclusive job creation and resilient knowledge economies.

More information:

Handbook Transdisciplinary Learning (Open Access)

<https://www.transcript-verlag.de/978-3-8376-6347-1>

Explainer Video Series Transdisciplinary Education

<https://www.tu.berlin/en/go254167>

2. What is Transdisciplinary Research?

*By Prof. Dr. Monika Gonser, Intersectoral School of Governance BW,
and Prof. Dr. Jochen Eckart Hochschule Karlsruhe*



Wind farm in Kazakhstan. Photo by Umurzakov, Pixabay

This section outlines the fundamental characteristics and instruments of transdisciplinary research. The three primary objectives that guide collaborative knowledge production within the quadruple helix framework are key among these. Numerous methodological approaches to supporting collaborative knowledge production exist, like e.g. stakeholder and interest analysis, backward mapping and a deliberate emphasis on fostering learning outcomes.

Three Goals of Transdisciplinary Projects

Transdisciplinary projects usually pursue three closely connected goals: a research goal, a practical goal and an educational goal. Together, these goals ensure that knowledge is not only produced, but also applied and shared.

The **research goal** focuses on generating new scientific knowledge. Researchers analyse complex problems, collect data and develop new concepts or methods. The aim is to better understand the causes and dynamics of a particular issue.

The **practical goal** focuses on developing solutions that can be applied in real-life contexts. This often involves working closely with practitioners, policy makers or community organisations. The goal is to translate research findings into measures, strategies or tools that help address the problem.

The **educational goal** relates to learning and capacity building. Transdisciplinary projects often involve students, professionals or community members. Participants gain new skills, learn from each other and develop a deeper understanding of complex challenges.

The topic of air pollution in cities can serve as a simple example to illustrate the different goals. Researchers from different disciplines such as pollution control, transport etc. might analyse pollution levels and identify the main sources of emissions, such as traffic, heating or industrial activities. This contributes to the **research goal**. At the same time, the project could work with city authorities and local organisations to design practical measures, for example the transition to public transport and electrification, or improved cycling infrastructure to reduce car traffic.



Workshop participant in an exercise on designing transdisciplinary education programmes, Bishkek, June 2025.

Photo by OSCE Academy in Bishkek.



A man with a bike walks on a street in Shahrisabz City, Uzbekistan. Photo by JoelleLC, Pixabay

This addresses the practical goal. Finally, the project may involve students or local residents in workshops and training activities that raise awareness and build expertise in sustainable urban mobility in civil society. This contributes to the educational goal.

Collaboration between Sectors: The Quadruple Helix

Transdisciplinary research typically brings together actors from several sectors with the aim to achieve more robust and widely accepted solutions for transfer challenges. This collaborative constellation is often described as the Quadruple Helix, referring to the interaction between the public sector, industry, academia and society. Projects of this kind are usually experimental, iterative and dynamic: ideas are tested in practice, refined through feedback and further developed through continuous collaboration.

Each sector contributes specific roles and resources to the transfer process. The public sector provides the broader strategic framework through policies, funding programmes and regulatory conditions. Industry and business actors contribute through research and development, entrepreneurial initiatives and the practical implementation of innovations, including production, marketing and distribution. Universities and research institutions play a central role in generating knowledge, conducting research, educating students, and supporting innovation through activities such as incubation or academic spin-offs. Finally, civil society offers an important perspective on societal needs and values. Citizens, community organisations and non-governmental actors can act as partners in experimentation, provide legitimacy for new solutions and contribute ideas for social innovation.

Collaborative Knowledge Generation and Integration

Transdisciplinary projects create new knowledge by bringing together researchers and stakeholders who are directly involved in real-world issues of transformation. Through this

collaboration, projects can access insights and experiences that are often difficult to capture through conventional research alone.

Knowledge generation in such projects takes two main forms. First, new data and information are collected through research activities such as surveys, observations or experiments.

Second, existing knowledge from different sources is combined and interpreted in new ways. Scientific expertise, professional experience and local knowledge are therefore integrated into a broader understanding of the problem.

Participatory methods play an important role in this process. They make it possible to include the everyday knowledge of practitioners, community members and other actors who deal with the issue in practice. By bringing together the stakeholders relevant to a particular transformation process, transdisciplinary projects create spaces for continuous exchange between science and practice. This interaction helps generate knowledge that is both scientifically robust and practically relevant.

Achieving Specific Results

Transdisciplinary projects often aim to generate concrete outcomes for the participants involved. A structured approach can help design activities that support these outcomes. The process begins by identifying existing gaps in knowledge and potential areas for learning. Based on this assessment, the desired learning outcomes are defined. The next step is to determine which processes are needed to achieve these outcomes and which activities should be implemented. It is also important to identify the relevant actors who should be involved in these activities. Finally, the process should include a reflection on the individual added value for participants, ensuring that each group benefits from the learning process and has an incentive to engage actively in the project.

Literature on the Quadruple Helix:

Lindgren, Monica; Packendorff, Johann (2010): A framework for the integration of a gender perspective in cross-border entrepreneurship and cluster promotion programmes. Hg. v. Quadruple Helix Central Baltic (Quadruple helix report, 6).

https://www.researchgate.net/publication/332151412_A_framework_for_the_integration_of_a_gender_perspective_in_cross-border_entrepreneurship_and_cluster_promotion_programmes (PDF Document)

Van Horne, Constance; Dutot, Vincent (2017): Challenges in technology transfer: an actor perspective in a quadruple helix environment. In: J Technol Transf 42 (2), S. 285–301.

https://www.researchgate.net/publication/308187219_Challenges_in_technology_transfer_an_actor_perspective_in_a_quadruple_helix_environment

Methods and Tools

Stakeholder Analysis

Stakeholder analysis is an important element of transdisciplinary projects. It helps identify the relevant actors for a project and clarify how they can be involved in the research and implementation process.

As a planning tool, stakeholder analysis helps ensure that all relevant groups are considered. It supports project teams in identifying actors from different sectors and assessing their interests, resources and potential roles. This makes it easier to design inclusive participation processes and avoid unintentional exclusion of important perspectives. At the same time, stakeholder analysis can reveal potential conflicts or resistance at an early stage, allowing project teams to address them constructively.

Stakeholder analysis also functions as an analytical instrument during the project. It helps researchers reflect on who is actually reached through different forms of participation and whether the intended actors are involved. In this sense, it acts as a form of quality control for participation processes. By analysing how stakeholders interact and contribute, project teams can assess whether participation has a meaningful impact and what kinds of changes it generates within the project and beyond.

Analysis of Interests and Conflicts

In transdisciplinary projects, it is important to understand the motivations, interests and potential conflicts among the stakeholders involved. Different actors may participate for different reasons: researchers may aim to generate new knowledge, public institutions may seek practical solutions for policy challenges, businesses may look for opportunities for innovation, and society actors may wish to address concrete problems in their communities.

A systematic analysis helps clarify how the interests of stakeholders relate to the research, practical and educational goals of the project. It also makes it possible to identify potential tensions or conflicting expectations, particularly when projects aim to implement practical solutions in real-world settings. Understanding these differences early on can help project teams design participation processes that balance interests and encourage constructive collaboration.

It is also useful to consider whether previous participation processes have taken place in the relevant social, spatial or technical context. Earlier experiences can provide valuable insights

into existing relationships, expectations and possible sources of conflict, helping projects build on existing knowledge and avoid repeating past challenges.

Backward Mapping

Backward mapping is a planning approach often used in transdisciplinary projects to connect long-term goals with concrete actions. Instead of starting with available methods or activities, the process begins by defining the desired outcome or transformation. From there, researchers and stakeholders work backwards to identify the steps, decisions and contributions required to achieve this goal. This approach helps ensure that project activities remain aligned with the intended impact and encourages participants to think strategically about the conditions and collaborations needed for change.

Example: If the goal is **improved nutrition for young children**, the first step should be defining the desired outcome: children regularly receive healthy and balanced food. From this outcome, necessary conditions can be identified, such as informed parents and caregivers, access to affordable nutritious food and supportive health and education services. The next step is to determine suitable interventions, for instance nutrition education programmes, training for childcare staff or partnerships with local food suppliers. Finally, concrete project activities such as research on nutrition habits, stakeholder workshops and pilot initiatives in communities are designed to support these interventions and contribute to the overall objective.

Literature:

Gonser M, Eckart J, Eller C, Köglberger K, Häußler E & Piontek F M (2019). *Unterschiedliche Handlungslogiken in transdisziplinären und transformativen Forschungsprojekten – Welche Risikokulturen entwickeln sich daraus und wie lassen sie sich konstruktiv einbinden?* (Different risk cultures of participants in living labs) In R. Defila & A. Di Giulio (Hrsg.), *Transdisziplinär und transformativ forschen. Eine Methodensammlung*. Band 2

Eckart J, Ley A, Häußler E, Erl T (2018) *Leitfragen für die Gestaltung von Partizipationsprozessen in Reallaboren (Questions for the desing of participation projects in living labs)* in Defila R, Di Giulio A (ed.) *Transdisziplinär und transformativ forschen : Eine Methodensammlung* 2018

Examples of transdisciplinary projects from Europe, Africa and Central Asia

TRANSDISCIPLINARY REAL-WORLD LABORATORY: ASYLUM SEEKERS (GERMANY)

Prof. Dr. Monika Gonser

One example of transdisciplinary research is drawn from the social sciences. The project "Real-World Laboratory: Asylum Seekers" was carried out in the Rhine-Neckar region in Germany and explored how the integration of asylum seekers can be supported more effectively in cities. It was implemented by the Leibniz Centre for European Economic Research in Mannheim (ZEW) jointly with the Heidelberg University of Education. The initiative brought together research institutions and around ten organisations from public administration, civil society and the private sector.

The project focused on several factors that influence successful integration. These included language acquisition, access to vocational training, entry into the labour market, decentralised housing and civic engagement. To investigate these issues, the initiative was organised into four interconnected sub-projects addressing

schooling, labour market integration, housing conditions and support from civil society. Researchers from the ZEW's Department of Labour Markets, Human Resources and Social Policy examined the individual and contextual conditions that shape labour market integration. Particular attention was given to young refugees who were seeking general or vocational training. Surveys conducted in 2016 and 2018 among around 300 refugees provided insights into employability, educational pathways and barriers to entering the labour market.

A defining feature of the project was the close collaboration between researchers and practitioners. The work not only produced scientific publications and data for further research, but also practical results that could be used directly by local actors. These included teaching materials for German language and mathematics, a network of self-organised learning desks designed to support the first steps in language learning, and targeted measures to improve labour market integration.

<https://www.zew.de/en/research-at-zew/real-world-laboratory-asylum-seekers>

COLLABORATION FOR ACTIVE MOBILITY IN AFRICA

Prof. Dr. Jochen Eckart, Hochschule Karlsruhe

The project "Collaboration for Active Mobility in Africa (CAMA)" focused on how walking and cycling can be strengthened as sustainable forms of everyday mobility in rapidly growing cities in Sub-Saharan Africa. The project brought together universities and research institutions from Germany, Kenya, Uganda and Ethiopia. It involved close collaboration with city administrations, civil society organisations and mobility practitioners.

CAMA concentrated on three urban case studies: Nairobi (Kenya), Kampala (Uganda) and Mekelle (Ethiopia). In many cities in the region, walking is already the most common mode of transport, yet urban infrastructure and planning often give little priority to pedestrians and cyclists. The project aimed to better understand everyday mobility behaviour, identify barriers to active mobility and develop locally adapted strategies for safer and more accessible urban transport systems.

A defining feature of the project was its transdisciplinary approach. Researchers combined technical and social-scientific methods with participatory formats that involved local stakeholders. Surveys, digital mapping of mobility infrastructure and traffic analyses were complemented by workshops and collaborative learning formats with urban planners, decision-makers, community representatives and transport practitioners.

These exchanges allowed research findings to be tested and discussed directly in the local context.

Beyond generating new scientific knowledge, the project also contributed to practical outcomes. It supported capacity building in sustainable mobility planning through training activities and exchanges between partner universities. By linking research, education and real-world urban challenges, CAMA helped develop knowledge and tools that can inform future mobility policies and infrastructure planning.

https://www.h-ka.de/en/ivi/projects/cama?utm_source=chatgpt.com

https://ids.uonbi.ac.ke/stakeholders-workshop-collaboration-active-mobility-africa-cama?utm_source=chatgpt.com

PILOT LIVING LAB ON CYCLING INFRASTRUCTURE IN BISHKEK

Dr. Kubatbek Muktarbek uulu, Kyrgyz State Technical University, Dr. Sebastian Schiek, SPCE Hub Network, Prof. Dr. Jochen Eckart, Hochschule Karlsruhe

The 'Pilot Living Lab on Cycling Infrastructure in Bishkek' was a small and short pilot, running from April to October 2022. Its main goal was to test transdisciplinary approaches and methods in practice and to initiate a debate on the prospects and challenges of transdisciplinary research in Central Asia. The project explored how knowledge can be co-produced across disciplinary and institutional

boundaries, and what conditions enable or hinder such collaboration in the Central Asian context. Cycling and cycling infrastructure in Bishkek, the capital of Kyrgyzstan, served as the concrete case through which the project explored these approaches. The project brought together universities from Kyrgyzstan and Germany. It was coordinated by SPCE Hub and the Friedrich Ebert Foundation and involved close collaboration with the city administration, the traffic police and the local cycling community. As a pilot, the project did not aim for a comprehensive intervention but used a focused, real-world challenge in sustainable mobility.

Given that the city administration was planning to enlarge its initial cycling grid, it started with the challenge of how cycling infrastructure can be expanded in a faster and more cost-effective way. To collect and integrate the necessary technical-, social-scientific and practitioner expertise, the project organised a series of workshops, street inspections and expert meetings that brought together traffic engineers, social scientists, urban planners, decision-makers and NGO representatives. An outcome was that it recommended testing different types of pop-up cycling lanes installed directly on the roadway as an alternative to separated bike paths. The ideas developed during the pilot continued to have an effect beyond the project duration: in September 2023, well after the project had concluded, the city administration implemented a pop-up cycling lane on Toktogul street in central Bishkek in cooperation with the NGO PeshCom. This later outcome demonstrated the practical potential of the approach, while

the wider aim of the pilot remained to reflect on what transdisciplinary research can offer in Central Asia.

Despite its modest scale, the pilot sought to stimulate a broader conversation about the role of transdisciplinary research in the region. Experiences from the Lab were shared through academic conferences in Brussels, Wuppertal and Leipzig and lectures on transport ecology, active mobility and air quality at Kyrgyz State Technical University, as well as during a research stay in Karlsruhe funded by the German Academic Exchange Service (DAAD).

<https://spce-hub.org/projects/pilot-living-lab-bishkek>

TRANSDISCIPLINARY RESEARCH ON WATER SECURITY IN TRANSBOUNDARY RIVER BASINS

*Dr Aliya Assubayeva, Assistant Professor
at the Graduate School of Public Policy,
Nazarbayev University*

In Kazakhstan, water users in the Balkhash-Alakol basin defined water security in practical terms, considering whether there is sufficient water for households, agriculture, industry, ecosystems and future stability. One interviewee compared a river system to 'blood vessels', highlighting the inseparable nature of upstream and downstream problems. Thousands of kilometres away in Ecuador's Mira-Mataje basin, Afro-Ecuadorian and Awa indigenous leaders had a different perspective on water. To them, the river



Street traffic at night in Bishkek, Kyrgyzstan. Photo by SonunJyldyz, Pixabay

was not just a resource; it was also part of community life, health, memory and survival. One community leader described how the river used to be 'live water', but is now damaged by pollution from palm oil production, mining and logging.

These two examples demonstrate that water security cannot be addressed through technical studies alone. It is not only a scientific issue, but also a governance, infrastructure, cultural and social one. The challenge is even greater in transboundary river basins because, while rivers cross borders, institutions, policies and priorities often remain national or local. Our research examined how water security knowledge can

be translated into action in two very different transboundary basins: the Aral Sea basin in Central Asia, and the Mira-Mataje basin, which is shared by Ecuador and Colombia. The study employed a transdisciplinary approach known as translational research, which is designed to connect scientific evidence with policy priorities and community perspectives. Instead of simply considering what the academic literature says, we explored how water security is understood by researchers, water professionals, policymakers and local communities. The evidence base was developed in three stages. First, we reviewed peer-reviewed publications on the Aral and Mira-Mataje basins. Secondly, two-round Delphi surveys were conducted separately with water professionals and stakeholders in the Aral and Mira-Mataje basins. Thirdly, we conducted field interviews with water users and river basin council members in Kazakhstan, as well as with Afro-Ecuadorian and Awa community leaders in Ecuador.

The results revealed significant regional variations. In the Aral Basin, experts prioritised economic water security, followed by household and urban water needs, water-related hazards and environmental concerns. They expressed particular concern about deteriorating irrigation systems, limited water supply facilities, inadequate drought forecasting and preparedness, and disputes over the allocation of water on transboundary rivers. In the Mira-Mataje basin priorities were different. Water governance was ranked as the top priority, followed by environmental concerns, household and urban water facilities, economic uses, and water-related hazards. Key concerns

identified by experts included limited consultation with communities, deforestation and biodiversity loss, insufficient wastewater treatment, inappropriate farming practices, and limited early-warning systems. In Central Asia, many of the recommendations focused on 'hard' infrastructure, such as the rehabilitation of irrigation systems and improvements to the supply of drinking water. Other recommendations concerned the management of droughts, the conservation of rivers and the strengthening of transboundary cooperation. In the Mira-Mataje basin recommendations placed more emphasis on 'soft' governance measures, such as engaging communities in decision-making processes, investing in human capacity and promoting integrated water resources management.

Despite these differences, the two basins face several shared problems. Both face increasing competition among water users. They both struggle with ageing, inadequate or poorly maintained infrastructure. They are both poorly prepared for climate-related hazards, including droughts, floods, landslides and extreme rainfall. They both demonstrate weak or fragmented governance, particularly with regard to stakeholder participation, data sharing, long-term planning, monitoring, and enforcement. A key finding was that the gap between research, policy and society is not merely a communication issue. It is an institutional problem. Scientific knowledge is often too technical, fragmented, or disconnected from the decisions that water managers and communities must make. At the same time, local knowledge is often dismissed as

anecdotal rather than being recognised as a valuable source of information for improving policy design.

Water security cannot be planned through engineering projects or national strategies alone. This requires institutions that can combine scientific evidence, professional judgement and community experience. River basin councils, watershed councils and community water boards can help, but only if their recommendations influence decision-making processes and they have the necessary resources, legitimacy and long-term support. The study therefore highlights the importance of knowledge synthesisers and brokers. Knowledge synthesisers bring together evidence from different disciplines and make it usable for decision-makers. Knowledge brokers connect researchers, government agencies, water professionals and communities, ensuring that evidence informs decisions and practices. In transboundary basins, these roles are particularly important because successful cooperation depends not only on data but also on trust, shared priorities, and sustained dialogue.

Read more: Assubayeva, A., Xenarios, S., Correa, A., & Forero, J. (2025).

Transdisciplinary research on water security in transboundary river basins. *iScience*, Volume 28, Issue 12, 113944.

3. Project Outlines Developed by Work- ing Groups

The workshop in June 2025 included numerous exercises aimed to generate ideas for potential research topics, apply transdisciplinary methods to the Central Asian context and reflect on their use. This section presents four sample projects that were developed by working groups during a brainstorming session. They should be understood as preliminary project outlines rather than fully developed project proposals. They would require further discussion and refinement before being implemented in practice.

These project outlines include experimental elements commonly used in so-called real-world laboratories or living labs, which are designed to generate knowledge in settings that are as close to real-life conditions as possible. The choice of topics reflects the strong focus of the workshop on environmental, energy and sustainability issues.

The Clean District Initiative

Reported by Dr Esentur Ivagov (lead), Dr. Anara Makatova and Turgaleyeva Akmaral Turgaibekovna, MA

Societal Problem and Relevance

Urban neighbourhoods often struggle with waste management, littering and maintaining clean, safe, and pleasant environments. The Clean District initiative addresses the societal problem of irresponsible garbage disposal and low community engagement in maintaining public cleanliness. This problem directly affects the quality of life for residents, the public image for local authorities and the business environment Bishkek, the capital of Kyrgyzstan.

The following stakeholders will be involved in the project:

- Residents will benefit from a cleaner, safer and more comfortable living environment.



A public backyard in Bishkek, Kyrgyzstan. Photo by SPCE Hub

- Local authorities will gain credibility and positive citizen feedback.
- Businesses will benefit from better aesthetics of neighbourhoods and will gain additional customers.
- Urban researchers will gain data for academic publications and funding.
- House leaders (Domcoms) will benefit from improved community satisfaction.

At the same time, certain stakeholders may resist change. For example, Tazalyk (the cleaning entity in Bishkek) may view the initiative as a threat due to sunk costs in their existing model. Disinterested residents and children may see the initiative pointless due to lack of understanding. Especially, residents might argue that they are already paying to local authorities for cleaning services.

Temporary Experiment

The experiment will last six months, covering data collection, intervention testing, monitoring and refinement. The aim is to learn which interventions are most effective in reducing littering, increasing compliance and fostering long-term community commitment.

The experiment will test behavioural interventions to improve waste management. Two main approaches will be implemented:

1. Mechanistic Approach (changing behaviour through "mechanical" influence)– adjusting waste collection logistics (location, signage, time of disposal, information on specific garbage collection) for convenience;

2. Educational Approach – disguised learning through community events, games, competitions, and performances aimed at children and adults, combined with a reward-punishment system.

Research Question

Which behavioural management strategies are most effective in reducing littering and improving waste disposal practices in urban neighbourhoods?

Academic Disciplines Involved

Each discipline involved will contribute unique methods and theoretical perspectives to ensure a holistic understanding of the problem.

- Urban Studies/Urban Planning will help analysing spatial layouts, infrastructure design and public space management.
- Sociology will help studying community dynamics, norms and collective behaviour.
- Behavioural Psychology can help testing mechanisms of habit formation, motivation and resistance to change.
- Environmental Science will measure ecological impact, waste reduction and sustainability outcomes.
- Economics will contribute with a cost-benefit analysis of interventions for households, businesses and municipalities.

Partners of Expertise and their Roles

- Domcom (house leader) will mobilise residents, monitoring participation.
- Residents will act as co-creators and direct beneficiaries of interventions.
- Businesses will act as sponsors of competitions, offering incentives.
- Local authorities will provide legal and infrastructural support.
- Tazalyk will act as a potential collaborator in integrating findings into city-level waste management.

Forms of interaction

- Information sharing at all stages (progress updates).
- Consultation in design and evaluation stages.
- Co-production of knowledge through experiments, data collection and decision-making with residents and local leaders.

Barriers and Enabling Factors

Barriers include:

- Resistance from disinterested residents or children unwilling to participate.
- Institutional inertia or lack of cooperation from Tazalyk.

- Limited financial and human resources for sustained interventions.

Enabling factors include:

- Community-based activities (cooking plot in the yard, competitions) to increase buy-in.
- Visible quick wins (cleaner streets, reduced litter) to maintain motivation.
- Support from authorities and businesses through funding and recognition.

Inclusion of Students and Transdisciplinary Learning

Students will play an active role in:

- Data collection and analysis (surveys, observations and waste audits).
- Event facilitation (designing games, competitions and educational performances).
- Knowledge co-production with residents and stakeholders.

This approach ensures transdisciplinary learning, where students not only apply academic theories but also engage with community members, authorities and businesses in solving real-world problems. Such involvement strengthens both research outcomes and the students' applied skills.

Green Circular Science Hub - Living Lab

Reported by Dr Bakhtiyor Eshchanov (lead), Agzamkhon Niyazkhodzhaev, MA, and Saida Yusupova, MSc

Societal Problem and Relevance

The project aims to create a sustainable university environment where science, education, business and society come together to promote green technologies, circular economy principles and sustainable development.

The main social problem the project aims to solve is the lack of a sustainable environmental culture and practical circular economy skills in the university environment in Central Asia. Most higher education institutions operate on a linear logic of resource consumption without fostering environmentally responsible behaviour among students. This creates long-term risks: low readiness of future specialists for the challenges of climate change, weak practical adaptation to the principles of sustainable development and missed opportunities to reduce the environmental footprint of academic institutions.

This problem is relevant both for educational institutions and for government structures, the business sector and civil society. The project will enable the training of a new generation of specialists capable of implementing sustainable practices. The direct beneficiaries will be



Workshop participants discussing their project. Photo by OSCE Academy in Bishkek.

students, teachers, university administrators and environmental NGOs interested in developing 'green' competencies.

Research question

How does integration of environmentally oriented practices and circular economy principles into the educational process influence the formation of sustainable behaviour, the development of environmental knowledge and the willingness of students and staff to apply green solutions in their professional and everyday activities?

Goals and objectives

The experiment involves the creation and testing of a "green laboratory" at one of the universities. It will operate according to the principles of the circular economy: waste collection and recycling (paper, plastic, laboratory materials), installation of energy-saving solutions and implementation of educational modules on sustainable development.

The aim of the experiment is to test whether it is possible to change the behaviour of students and staff in a short period of time (two months) by involving them in practical work with green

technologies, and whether it is possible to measure the reduction in negative impact on the environment.

Duration of the experiment: 60 days, including monitoring, participant engagement, analysis, and reporting.

Implementation stages

Phase 1. Initiation (first steps)

- Preparation of the concept and partnership agreements.
- Launch of minimal infrastructure: pilot showroom, website and initial consultations.
- Formation of research groups, selection of residents for the accelerator

Phase 2. Stakeholder engagement

- Raising public awareness.
- Creation of financial instruments to support green technologies.
- Organisation of training events and conferences

Phase 3. Orientation and institutionalisation

- Coordination of educational, scientific, demonstration and communication activities.
- Launching research modules and acceleration programmes.
- Expansion of infrastructure and preparation for scaling up
- Green Science Hub Living Lab.

Structure of participants and partnerships

Universities and scientific institutes – joint projects, courses and research.

Businesses and green technology manufacturers – memoranda, accelerator and prototyping.

Government agencies and municipalities – placement, co-financing and project support.

Financial sector – development of green credit products.

NGOs and local communities – training, events and joint research.

Academic disciplines and their contribution

The project is distinctly transdisciplinary in nature. It involves the following disciplines:

Ecology and the environment - assessment of the laboratory's impact on the environment and development of environmental audit methodologies.

Economics - analysis of the effectiveness of resource-saving strategies, development of savings models.

Education - design of training courses and methodologies on sustainable development.

Sociology - analysis of behavioural changes and social barriers.

Engineering/IT - implementation of digital monitoring systems (sensors, consumption and control).

This comprehensive approach will enable the construction of a sustainable and replicable model suitable for scaling.

Partners of expertise and forms of interaction

The project relies on close interaction with external stakeholders:

- Municipal services (waste disposal) - removal of recycled materials.
- Environmental NGOs - consulting and training events.
- Business companies - provision of equipment and technical support.
- University administration - logistics, permits and resources.

Forms of cooperation

Informing at all stages through presentations, brochures, reports.

Consulting during design and implementation (especially with businesses and NGOs).

Joint knowledge creation through workshops and co-authoring research materials.

Benefits and expected results

For citizens - sustainable access to resources (clean energy, water and heating).

For the state - fulfilment of international commitments on sustainable development.

For businesses - new markets, increased turnover and prototyping opportunities.

For academia - new research projects, grants and international partnerships.

For students - practical experience, internships and participation in interdisciplinary projects

Green Science Hub Living Lab.

Potential barriers and success factors

Barriers:

- Lack of experience among teachers in integrating green concepts.
- Limited financial resources.
- Administrative difficulties in launching the pilot.

Success factors:

- Support from international donors.
- Student motivation.
- Flexibility of educational programmes.
- Opportunities for digital promotion of the project.

Conclusion

The Green Science Hub Living Lab project is a cutting-edge model of a sustainable university environment that seamlessly integrates scientific research, practice-oriented education and local community involvement. The initiative applies an interdisciplinary approach to addressing pressing environmental and social challenges, promoting the development of competencies in the field of circular economy, sustainable production and consumption.

The planned pilot experiment creates conditions for testing scientifically based methodologies in a real academic environment, allowing collecting empirical data, identification of effective mechanisms for interaction between stakeholders, and adaption of sustainable development models by the university campus.

The results obtained during the experiment will form a solid basis for the further institutionalisation of the laboratory. They will enable its scaling to other educational institutions and its integration into national educational and research programmes on sustainable development and green transformation.

Plastic Bags - Living Lab for Sustainable Waste Reduction in Tajikistan

Reported by Segbegim Mirzosaidova (lead), Dr. Aliya Assubayeva and Dr. Serik Orazgaliyev

Societal problem

Plastic pollution has become one of the most visible and urgent environmental challenges in Tajikistan. Every resident of major cities in the country discards over one kilogram of solid waste per day, with single-use plastic bags forming a significant portion of this waste. The uncontrolled accumulation of plastic pollutes rivers, soil, and ecosystems. It harms biodiversity and poses risks to human health. At the same time it reflects deeper systemic challenges - from weak waste management infrastructure and low public awareness to a lack of policy instruments and market incentives for sustainable alternatives. Addressing this problem requires a systemic and collaborative approach that brings together different disciplines, actors, and sectors to co-create actionable solutions.

Experiment

The Plastic Bags - Living Lab project was conceived as a transdisciplinary initiative designed to tackle this issue by integrating policy innovation, behavioural change, community engagement, and research-driven experimentation. It applies the Living Lab methodology - an approach that tests solutions in real-world settings through collaboration between researchers, policymakers, businesses, civil society, and citizens.

The overarching aim is to design, implement and evaluate a set of interventions that significantly reduce single-use plastic consumption, promote sustainable habits and generate evidence-based policy recommendations for wider application across Tajikistan and beyond.



View on the city of Khorog, Tajikistan. Photo by OlgaRonskaya, Pixabay

At the heart of the project is a 12-month pilot experiment that combines regulatory measures, economic incentives, and social innovations. Policy tools such as mandatory payments for plastic bags and tax incentives for producers of eco-friendly alternatives aim to create structural changes in consumer and producer behaviour. Simultaneously, behavioural interventions, including public awareness workshops, animated educational campaigns, loyalty programs for customers who bring reusable bags, and buyback schemes for used plastic, are designed to shift social norms and encourage sustainable choices. Retail spaces will feature “used bag corners” for sharing and reusing bags, while public installations will visualize the scale of plastic waste, stimulating dialogue and reflection.

Academic disciplines and their contribution

Environmental science, economics, sociology, policy studies, and business management

Partners of expertise and forms of interaction

The project’s strength lies in its multi-stakeholder structure:

- Government agencies are crucial partners, supporting policy implementation, monitoring and data collection.

- NGOs and advocacy groups lead awareness efforts and mobilise community participation.
- Recycling companies and waste management organisations provide technical expertise and infrastructure for sorting and repurposing plastic waste.
- Retailers, both large and small, implement payment schemes and pilot customer engagement strategies.
- Consumers play a central role as change agents.
- Academic institutions contribute interdisciplinary expertise from environmental science, economics, sociology, policy studies, and business management - ensuring that the project design, implementation, and evaluation are grounded in robust research and theory.

Barriers and enabling factors

While the project's ambition is significant, it acknowledges potential barriers, including resistance from businesses concerned about costs, public reluctance to change daily habits, and financial constraints in producing sustainable alternatives. At the same time, strong enabling factors, including government commitment to sustainability goals, increasing public awareness, global momentum against plastic pollution, and local entrepreneurial capacity, provide a favourable environment for success. The project's iterative, participatory design allows for continuous learning and adaptation, ensuring that challenges are addressed and opportunities leveraged.

Ultimately, the Plastic Bags – Living Lab project aims to demonstrate how collaborative, real-world experimentation can drive systemic change. By combining policy measures, market mechanisms, community engagement, and academic research, the project aspires not only to reduce single-use plastic consumption but also to contribute to the broader goals of environmental sustainability, public health, and circular economy development in Tajikistan. Its outcomes will provide valuable insights for policymakers, businesses, and educators, and offer a replicable model for tackling similar environmental challenges across Central Asia.

Students/transdisciplinary learning

The project places strong emphasis on experiential and transdisciplinary learning by integrating students into all stages of the process. They are involved in conducting baseline research, designing awareness campaigns, analysing behavioural data, and co-developing solutions alongside stakeholders. This approach not only enhances their practical skills and understanding of complex socio-environmental challenges but also demonstrates the value of higher education as an active contributor to community transformation. Students learn how research can be applied beyond academia and how collaborative knowledge production can create real impact.



Traffic jam in Bishkek, Kyrgyzstan. Photo by Ilgizsydykulov, Pixabay

Talas Green Transport Infrastructure

Reported by Dr Kishimjan Osmonova (lead), Professor Ermek Baibagyshov, Professor Amanbek Altybayev and Professor Zhyrgalbek Sharshembiev

Societal problem

The project aims to solve the problem of heavy traffic and pollution in Talas city, Kyrgyzstan, as well as to promote sustainable and green forms of mobility such as walking and biking. Currently, private cars dominate as the main means of transportation, which leads to overcrowding of roads. This results in severe traffic congestion, air pollution and unsafe surroundings for pedestrians.

The traffic problem concerns many stakeholders. The city municipality is the main decision-maker responsible for regulating traffic, enforcing rules on public space use, and ensuring safety together with the traffic police. The main beneficiaries are the citizens, who would directly benefit from cleaner air and safer streets that encourage walking and biking. Scientists

would gain research insights related to climate and environmental protection, while also proposing practical solutions to social problems. Local practitioners and businesses would benefit from cleaner and safer streets which can attract more customers, create new jobs, and improve the overall quality of life in the city.

Temporary experiment

The project includes two social experiments. The first one will test a walking app, encouraging city residents to walk instead of driving cars or taking taxi. Most residents use their cars to commute to work or handle daily activities. Furthermore, cars are often seen as symbols of wealth and societal status in Kyrgyzstan. Therefore, to promote walking or biking, not only physical infrastructure but also a change in citizens' attitudes should be enabled. The walking app aims to make walking positive, social, and rewarding.

In the app each neighbourhood will be identified as one community that collects walking points. Citizens will be able to see and compare areas, which collected the most points. To earn points, residents will need to walk instead of driving. At the end of each month, the points will be tallied, and small rewards will be distributed. The neighbourhoods with the most walking points could receive reduced waiting times for city services or small discounts on electricity. The project will seek partnerships with local businesses to support these incentives by donating rewards or offering small gifts to active participants.

The second experiment will be a monthly "car-free day" in the city centre. On this day, the main streets around the market, usually overcrowded with cars, will be open only for pedestrians and cyclists. This will allow citizens to experience the city centre without cars. It will serve as a visual and social contrast to the usual car-dominated streets and promote creative and pedestrian-friendly use of public space. The goal is to shift perceptions and remind residents that streets are public spaces for everyone, not just for cars.

The overall aim of these social experiments is to change the attitudes of both car owners and pedestrians toward alternative means of transportation. The experiments will last one year. We want to gain insights into how citizens feel about being directly involved in solving social problems that affect their daily lives. Do they feel empowered and encouraged? What challenges do pedestrians face while walking instead of driving, for instance, social pressure or discouragement from car owners?

Research questions

How can citizen-driven experiments inform municipal strategies for reducing car dependency and improving sustainable mobility in Talas? How does direct citizen participation in mobility experiments influence attitudes and behaviour toward green transport in Talas?

Academic disciplines and their contribution

- Software engineers and application developers will collaborate with social and transport scientists to design, plan, and implement the walking app.
- Social scientists will ensure the app is culturally sensitive and reflects the everyday realities of city life.
- Transport engineers will identify the most commonly used pedestrian routes to help plan future infrastructure.

Partners of expertise

- The city municipality will provide access to maps and street layouts to define community boundaries for the walking app.
- Local businesses will act as sponsors to encourage citizen participation.
- Before the app is developed, city residents will be interviewed about their interest and their ideas for improving green mobility.

Collaboration between academic and partners of expertise will be based on equality - each should learn from the other. The dominance of the city municipality should be balanced to ensure that citizens' voices are equally heard. The role of the city administration will be to collect feedback about walking challenges in order to improve street planning and infrastructure design together with transport experts.

A communication platform within the walking app will allow citizens and stakeholders to exchange information and share feedback. Citizens will be involved throughout all stages of the project, while the municipality and business partners will be consulted at key points. Academic partners will serve as project coordinators and facilitators. In the end, the project results will be co-produced, with each stakeholder reflecting on the challenges and benefits they experienced.

Barriers and enabling factors

The experiment may fail or partially fail. Projects involving many stakeholders face barriers, and communication between them must be carefully planned. Seasonal changes may also affect outcomes - for example, residents are likely to drive more in winter and walk more in summer.

Students

Students will be indirectly involved. They will interview residents about their opinions on walking and on using the app, gaining first-hand experience in transdisciplinary research. Moreover, students will help organise small street events on car-free days to make the activities more engaging and community-oriented.

4. Best Practices from Central Asia

During the workshop, it became clear that transdisciplinary approaches already play a role in Central Asian universities. They are being particularly applied in the field of education, even if are not always identified as such. Their application often still depends on the individual commitment of lecturers. Institutional support and integration into strategic initiatives remain at an early stage, but are gradually gaining momentum.

Below, four lecturers at Central Asian Universities present examples from their own practice.



View on Almaty, Kazakhstan. Photo by Ilana246, Pixabay

“Serving Society”: An Innovative University Course in Kazakhstan

By Dr. Akmaral Turgaleyeva, Member of the Board for Educational, Social Issues and Interaction with Employers at the Kozybayev University, Petropavlovsk, Kazakhstan

In 2023, Kozybayev University introduced the course “Serving Society”, marking a new approach to student learning in Kazakhstan. Over 1,000 first-year students at Kozybayev University

participated. During the course students chose projects close to their hearts and learned by doing, making a tangible difference in their communities. Some focused on environmental protection and others helped children, the elderly, or vulnerable groups. Student projects also included promoting Kazakh language, financial and legal literacy, and health initiatives.

Stakeholders Involved

Students, university administration, social organizations, orphanages, animal shelters, crisis centers, veterans' associations, and local communities were all involved.

Students developed their teamwork, project management, and leadership skills while creating real impact. They planted 50 trees, collected and recycled 42 kg of plastic, raised over 180,000 KZT for charity, and assisted multiple social institutions, including orphanages, animal shelters, and veterans. Students gained empathy, civic responsibility, and a desire to contribute to society. Communities directly benefited, creating a cycle of learning and giving.

"Serving Society" breaks from traditional methods by combining experiential learning with student initiative and social impact. Seventy projects were carried out, many receiving public recognition. Students did not just study - they acted, reflected, and created change. The course successfully fostered empathy, responsibility, and engagement. This way it set a powerful example for socially conscious education.

Transdisciplinary Teaching Methods in Strategic Management and Marketing, Tajikistan

By Sedbegim Mirzosaidova, Lecturer of Economics at the University of Central Asia

Integrating transdisciplinary approaches into higher education equips students to solve complex real-world challenges. In my strategic management and marketing courses at the University of Central Asia, I developed methods that connect theory with practice, engage stakeholders, and generate social impact. These approaches - service-learning projects, entrepreneurship education, and student-organised teaching - emphasize experiential learning, co-creation of knowledge, and societal relevance, transforming traditional instruction into active, collaborative, and impactful learning.

A core method is service-learning, where students work directly with local businesses and organisations in Khorog, Tajikistan. They conduct market research, analyze competition, and develop marketing strategies and strategic plans tailored to company needs. Local SMEs, social enterprises, and entrepreneurs are involved throughout the process, ensuring relevance and applicability. Students develop skills in strategic analysis, research, and stakeholder communication, while companies benefit from innovative recommendations. This collaboration



Badakhshan mountains, Tajikistan. Photo by Makalu, Pixabay

also builds stronger links between the university and the local economy. Entrepreneurship education further enhances transdisciplinary learning by encouraging students to identify local needs and design products or services that are both profitable and socially beneficial. Through field research and collaboration with community representatives and potential customers, students gain entrepreneurial thinking, creativity, and problem-solving skills. Communities benefit from new business models and solutions addressing socio-economic challenges, promoting inclusive and sustainable development.

Student-organised teaching complements these methods by giving students responsibility for designing and delivering sessions. They choose topics, research, prepare materials, and lead discussions, which deepen understanding and build confidence. Engagement with peers, faculty, and practitioners enriches the process and fosters collaborative learning. This approach shifts students from passive learners to active knowledge producers and develops leadership, communication, and pedagogical skills.

Together, these methods move beyond conventional teaching by embedding students in real-world contexts, involving external stakeholders, and promoting co-creation. They equip

students with critical professional competencies while delivering tangible value to local businesses and communities, demonstrating how higher education can actively contribute to sustainable regional development.

Transdisciplinary methods in the RE.Act project

By Prof. Ermek Baibagyshov, Naryn State University, Kyrgyzstan

The Technical University of Ingolstadt, in collaboration with Naryn State University (NSU) in Kyrgyzstan and the Tashkent Institute of Irrigation and Agricultural Mechanisation Engineers (TIIMA) in Uzbekistan, is implementing the project Renewable Energy Action: A Sustainable Water-Energy Nexus Partnership for Higher Education in Central Asia (RE.Act).

As part of the project, a summer school for students and teachers from partner universities was organised in July 2025. The summer school focused on the practical and theoretical aspects of sustainable development, in particular the integration of water and renewable energy resources. The programme included lectures by invited experts, group projects and excursions, which gave participants a comprehensive overview of these topics. The summer school became an important platform for international exchange, fostering a favourable environment for cooperation between students and young researchers.

On the first day of the summer school, the RE.Act Forum was organised. This international event brought together representatives from Germany, Kyrgyzstan and Uzbekistan. The main goal of the forum was to promote innovative solutions for sustainable development through the integration of water and renewable energy resources. The event also served as a platform for dialogue, exchange of practical knowledge and strengthening of partnerships between the scientific community and the private sector.

Students participating in the summer school expanded their knowledge of sustainable development, the efficient and rational use of water and energy resources, and the possibilities for using renewable energy sources.

A competition on Sustainable Development Goals (SDG) was organised among the students. The winners (one student from each partner university) received the opportunity to undertake a three-month internship at the Technical University of Ingolstadt, Germany, from October to December 2025.

Embedding Living Lab Principles into Teaching Practice At Universities

By Dr. Serik Orazgaliyev, Associate Professor at the Graduate School of Public Policy, Nazarbayev University

The training on transdisciplinary education and living lab approaches at the SPCE Hub 2025 workshop provided valuable insights into ways universities can bridge the gap between academic learning and societal challenges. Inspired by these discussions, the following concept outlines a model for embedding living lab principles into teaching practice, particularly within public policy and sustainable development courses at universities.

The idea is to create a practice-oriented learning format in which guest speakers, including policy-makers, civil society representatives, and development practitioners. Speakers will share their work and, crucially, present authentic policy or development problems. Students will work in interdisciplinary groups to research and propose evidence-based solutions using tools such as stakeholder mapping, cost-benefit analysis, and policy evaluation.

Faculties could act as facilitators and methodological guides, while partner organisations could serve as problem owners and provide feedback throughout. This collaborative setup reflects the living lab approach emphasised in the SPCE Hub workshop, where real-world problems are explored jointly by academia representatives and practitioners to generate actionable knowledge and policy insights.

Students can engage with these challenges as part of a semester-long course project or an extended capstone project spanning several semesters. This learning format can enhance students' analytical and teamwork skills. It can also help future professional engagement - students often build connections with partner organisations that may later lead to internships or employment.

Overall, the concept aims to cultivate a transdisciplinary learning environment that connects research, teaching, and practice. By co-creating solutions to real policy issues, students strengthen their competencies and bring positive change to their home institutions and communities.

Editors

SPCE Hub Network,
Intersectoral School of Governance BW,
OSCE Academy in Bishkek

Edited by

Komila Nabiyeva, Kishimjan Osmonova,
Sebastian Schiek, SPCE Hub Network

Design & Art Direction

Bárbara Fonseca

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Contact: info@spce-hub.org | isog@cas.dhbw.de