Growing critical minds and cultivating solutions: Design Thinking as a useful toolkit and mindset for a project-based learning environment

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Abstract

In the face of contemporary global challenges such as food security, climate change, and socio-economic inequalities, fostering critical and creative thinking skills in higher education is paramount. Besides domain-specific expert knowledge, transferable competencies of graduates have become increasingly important in addressing current challenges by embracing complexity and integrating diverse backgrounds. This study explores the integration of Design Thinking within a project-based learning framework to enhance these competencies among agroecology students. The course 'Agroecologist Without Borders', offered at ETH Zurich, serves as a case study. Students engage with stakeholders and specialists, fostering a rich exchange of knowledge that directly impacts their learning outcomes. The course employs a transdisciplinary approach, integrating diverse disciplines and environments, with Design Thinking guiding students through understanding, empathizing, defining, ideating, prototyping, and testing solutions to real-world challenges. This approach serves as a model for future educational initiatives, highlighting the importance of fostering both critical and creative thinking in higher education.

1. Learning through projects as a nucleus for growing critical minds and creative solutions in the field of agroecology

In this study, we will explore the significance of project-based learning in higher education to create a transdisciplinary learning experience for students interested in the field of agroecology and sustainable agroecosystems at ETH Zurich. Using Design Thinking as an approach to project-based learning fosters not only methods and subject-specific competencies, but also social and personal skills. These include critical thinking, creativity, and problem management (Hajriani et al., 2025; Hawthorne et al., 2016), while also addressing contemporary crises such as food system resilience and nutrient cycling in a participatory manner.

Design Thinking originated at Stanford University in the 1960s as a highly human-centered and collaborative approach to problem-solving in real-world challenges. Since then, it has been applied across various contexts and fields. In education, it serves as an innovative approach for project-based teaching, fostering engagement with stakeholders and real-world issues (Brown, 2008; Jia et al., 2023; Ji Jiang & Pang, 2023).

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In our context, this teaching approach involves consistent and tangible engagement with stakeholders and students enrolled in the course 'Agroecologist Without Borders' during the spring semester at ETH Zurich. In this course, students engage in a participatory learning experience alongside stakeholders and specialists, fostering a rich environment where knowledge and insights are exchanged, directly influencing student learning through their design thinking projects. The course is created as a Design Thinking process and is based on a collaboration with the University of KwaZulu Natal in Pietermaritzburg, South Africa.

This article examines 'Agroecologist Without Borders' as a multifaceted project-based learning experience that integrates diverse disciplines and environments. We outline the course's conceptual framework, clarify its design principles, and discuss challenges encountered, aiming to advance educational initiatives in agroecology.

Agroecology - A journey towards transformation

Agroecology is a way of redesigning food systems, from the farm to the table, with the goal of achieving ecological, economic, and social sustainability (Gliessman, 2018). Moreover, agroecology is understood as a realm where science, practice, and social movements converge to seek a transition to sustainable food systems built upon the foundations of equity, participation, and justice (Méndez et al., 2013). In this regard, agroecology is deeply rooted in practice and real-life projects, where experiments and trials constantly feed scientific insights and vice versa (Nicholls and Altieri, 2018; Francis et al., 2020; Gliessman, 2022). Shifting toward agroecological and food system transformation implies building a global food system based on participation, localness, fairness, and justice (HLPE, 2014). Amidst climate emergency, biodiversity collapse, and ecological degradation, fundamental changes addressing systemic injustices, inequalities, and human-earth relationships are necessary, and students from a broad range of curricula are increasingly craving tools and approaches that would help address these pressing issues. For this reason, Agroecology is increasingly recognized as a crucial issue in education for tomorrow's scholars, professionals, and citizens (David & Bell, 2018).

Transdisciplinarity to bring realities closer to the learning environment

While system thinking and interdisciplinarity have been brought up in diverse agroecological curricula throughout recent decades (David & Bell, 2018), the possibility to exchange and ideate with a broader range of practitioners is bringing the students closer to the realities of the field (Pohl et al., 2020). Displaying subtly, and sometimes violently, the challenges and complexity that can be faced by communities across the world when questions and innovating towards agroecological transition. In this regard, transdisciplinarity appears as a complementary way to address agroecology and understand better how to engage in a transformative process. 'Transdisciplinarity is a reflexive research approach that addresses societal problems by means of interdisciplinary collaboration as well as the collaboration between researchers and extra-scientific actors; it aims to enable mutual learning processes between science and society; integration is the main cognitive challenge of the research process.' (Jahn et al., 2012 (3)) Through experiential learning that may embrace project-based learning as well as action learning, agroecology education can promote that transformation among both teachers and learners (Lieblein et al., 2004; Francis et al., 2020). A promising way to impel a change in students' learning and being is through transdisciplinary processes, including societal actors, various practitioners, thinkers, and researchers (academic and non-academic). Setting up transdisciplinary platforms in learning environments allows for exchanging, collaborating, practicing, and experimenting together toward a commonly defined goal and shared values. In order to ensure an enriching learning experience and achieve long-term objectives in such innovative learning environments, it is crucial to provide thoughtful guidance and planning regarding constructive alignment from the teacher (Lieblein et al., 2004; Biggs et al., 2022). If the learning environment is designed with this in mind, transdisciplinary projects can introduce creative perspectives on everyday actions and interactions for both teachers and students in a coherent way. Learning objectives are planned with the question in mind: what should students be able to do after completing the course? Learning activities and assessments are then designed to align with these objectives, ensuring that students have the opportunity to develop the targeted competencies and are assessed accordingly (Reynders et al., 2020; Biggs et al., 2022). In 'Agroecologist Without Borders,' we provide a space for reflecting on projects using transdisciplinary methods and offer opportunities to contribute by following the Design Thinking process. These active learning methods should also critique hegemonic approaches to producing and imposing certain findings and narratives, fostering critical thinking and creativity around these topics.

Finding oneself at the intersection of science and society

Environmental and agricultural students in institutions like ETH Zurich are expected to be change-makers, embodying the hope for a sustainable future. They are asked to develop meta-analyses of global socio-ecological dynamics and respond to the urgency of our current situation at various scales. However, given the vast scope of these challenges, it is essential to shape this educational process in a coherent and grounded way. This requires building bridges between disciplines, their real-life applications, and their socio-ecological impacts while also engaging with existing alternatives and enabling rooms for creative ones paving transformative paths.

To navigate what might seem like an overwhelming task, in a healthy and sustainable manner, students need room to digest, process and learn while actively experimenting, sharing and contributing to on-going societal questions, such as the one related to whom feeds us and how? Or in what ways are we handling our wastes and why?

For students, a semester can feel like an overwhelming accumulation of courses to complete alongside classes, labs, excursions, reports, and numerous exercises – often focused solely on passing and progressing through a demanding, high-pressure, and rigorous academic journey. This structure limits opportunities for students to pause, reflect, question, and process the knowledge they acquire.

In a vibrant political context where the universities are oppressing and silencing students asking themselves questions in relation to social and climate justice, it is also important to foster more liminal spaces for critical reflection. If scientists are asked to be rigorously present in the public debate in this context, establishing links between self-reflectivity and awareness is essential. Students should be encouraged to embrace diverse perspectives, be able to think outside the box, and adopt a fail-forward attitude. The teacher plays a key role as an enabler of space that can foster such approaches, initiating regular reflection loops to steer the learning experience in a meaningful direction (McLaughlin et al., 2022). Furthermore, while AI tools are increasingly useful for navigating studies, critical reflection is necessary to avoid becoming overwhelmed by algorithmic speculations.

While some universities deliberately allocate time and space for students to absorb lectures, engage in discussions, and self-document their learning, others prioritize competitiveness and performance at the expense of these reflective moments. Thus, universities occupy an ambivalent role, serving both as spaces for intellectual growth and potentially alienating environments. Recognizing this tension, educators can shape their courses as liberating platforms – creating breathing room and fostering porous exchanges that nurture critical thinking.

Finding oneself at the intersection of science and society, a myriad of tools exists to facilitate the journey back and forth and shed light on the potential for sustainable food systems transformation.

2. The conceptual framework of the course and the learning environment

The course

Historic context

'Agroecologist Without Borders' is a course offered in the Department of environment system and sciences D-USYS of ETH Zurich since 2015. During the pandemic, the shift to an online format facilitated participation and dialogue across continents in new ways, ones that have presented previously unimagined possibilities. In keeping with the participatory and transdisciplinary spirit of RUNRES project itself, we decided to exchange more closely with a wide range of key actors engaged in the transition towards a sustainable and equitable community. This multi-stakeholder group, led by the project manager and the postdoctoral researcher and composed of other researchers, agricultural extension officers, local university students, the school community, and staff, worked intensively with the ETH Zurich students.

The course welcomes master students of agricultural and environmental sciences, and since 2024, it has also been open to architectural students. The goal of 'Agroecologist Without Borders' is to introduce students to the complexity and challenges, both biophysical as well as socio-economic, inherent in agricultural development interventions, and to develop their science communication skills by producing outreach materials in the context of a given case study. In groups, students are invited to develop a science communication toolkit for The Bishopstowe Agroecology Living Lab (BALL) in Msunduzi, South Africa: Addressing agroecological transition in learning by doing. Over the last few years, the Sustainable Agroecosystems research group has organized this course around a case study related to an ongoing agricultural research project in Africa. For example, past courses studied efforts to support agroforestry in central Malawi or organic soil fertility management in Mozambique.

RUNRES project

Since 2021, the course has focused on the ongoing research and development project 'The Rural-Urban Nexus: Establishing a nutrient loop to improve city region food systems resilience (RUNRES). RUNRES is an eight-year project with the overarching goal of improving sustainable and resilient city region food systems in four sites across Sub-Saharan Africa: Arba Minch, Ethiopia; Kamonyi, Rwanda; Bukavu, DRC; Msunduzi, South Africa. Composed of a diverse and interdisciplinary team of academics and practitioners, the project objective is to support a circular food system predicated on the capture and processing of currently undervalued waste streams to provide locally sourced and sustainably processed nutrients capable of maintaining soil health and fertility. Although RUNRES is introducing numerous interventions such as municipal scale composting, enhanced small-scale food processing, or fecal sludge pyrolysis to facilitate this change, 'Agroecologist Without Borders' has focused specifically on three innovations co-developed within the team led by Prof. Odindo at the University of KwaZulu Natal in Pietermaritzburg, South-Africa: 1) The 'Decentralized Wastewater Treatment Systems' (DEWATS): a way to improve the sanitation in a rural South African school, while also contributing to community-based economic development and environmental health. 2) The DUZI-Turf co-composting facility: producing compost from sewage sludge and urban green waste. 3) The Bishopstowe Agroecological Living Lab: a knowledge center, learning, and experimental platform based in the outskirts of Pietermaritzburg and aimed at scaling out circular bioeconomy and agroecological innovations.

Thus, the objective of the course was to provide the students an opportunity, in a structured and facilitated environment, to co-develop locally appropriate communication and outreach material capable of supporting the successful adoption of this novel technology among local communities.

Learning goals and ETH Competence Framework

There are seven distinct learning goals set for the students in this class:

1. Students analyse a concrete example of an agricultural research project.
2. Students broaden their understanding of environmental and socio-economic challenges within a Living Lab.
3. Students engage with positive and empowering frameworks that encourage critical reflection and action on the transformative responses needed within agricultural and food systems.
4. Students articulate the complexities and challenges involved in agricultural development interventions.
5. Students develop science communication skills by producing materials in the context of the given case study.
6. Students practice their project management skills.
7. Students engage in a Design Thinking process.

For each goal, a set of competencies borrowed from the ETH Zurich Competence Framework has been established. In this regard, we aimed to foster not only subject- and method-specific competencies but also to actively work on more personal and social competencies of the students.

Structure, tools, and learning environment

The class is structured with various sessions, ranging from theoretical inputs to guest lectures that provided inspiration through diverse case studies to key presentation moments where each group updated their peers in front of the class and a time for discussing it in plenum with lecturers and students.

The course provides 4 hours of direct instruction per week during the spring semester and is worth 3 ECTS credits. Following student feedback, one additional credit was incorporated. The assessment consists of a graded semester performance, which includes a group project focused on developing a scientific communication toolkit for a selected project, alongside an individual assessment composed of a two-page personal reflection on the project.

The teaching strategy emphasized encouraging collaborative work on students' projects, fostering a positive atmosphere by sharing food during the break, starting with a reading session as a way to land in the space, and bringing important questions on critical thinking for teaching and check-out board to express where one finds themselves at the end of the course and aims to host and provide safe space for discussion, conflicts, and understanding.

The course is supported by an innovative transdisciplinary framework and online tools such as Zoom, WhatsApp, and Miro. These tools were used to map the system, gather data, produce insights, and reflect on the system's main components. Zoom is utilized for general course sessions, involving active participation from lecturers, project managers, and other guests located in South Africa. WhatsApp facilitates direct communication, especially with the South African team, as it is the most convenient way to initiate meetings or catch up. Miro is an effective tool for observing student progress during exercises and guiding them step-by-step through the various topics and perspectives covered in the lecture.

Ultimately, the course took place in the SAE Greenhouse Lab at ETH Zurich, an old greenhouse now used as a teaching and outreach space. The greenhouse, filled with diverse plants – tropical ones and those from other students’ projects – offers a uniquely inspiring environment. This unique tool is a major element that provides a cocoon-like feeling for the students, allowing them to grow alongside the spring plants around them.

Creating an appropriate environment with Design Thinking as an underlying process for project-based learning

Different layers in the course

We identify three different layers in the course (see Fig. 1). Project-based learning is a guiding educational approach, and Design Thinking is one process to follow while working on real-world challenges in a structured way. Through this applied project-based learning approach in the course, students are encouraged to take ownership. The design thinking process enables them to engage in regular check-ins. The process is also structured in a way that allows students to draw from multiple disciplines, helping them connect different subjects from their curriculum, such as nutrient cycling and environmental project management. Throughout the process, students' input is used to refine the project experience for future classes and nourishes iterative adjustments. Furthermore, we believe this course provides them with valuable insights and tools applicable to other courses and their future professional endeavours. Students need to communicate complex systems, topics and matters comprehensively to a diverse array of stakeholders, from farmers to school kids. The students remain integral to this project, as it is in collaboration with them during the 'Agroecologist Without Borders' course that we co-develop tools and resources to fortify their skills.

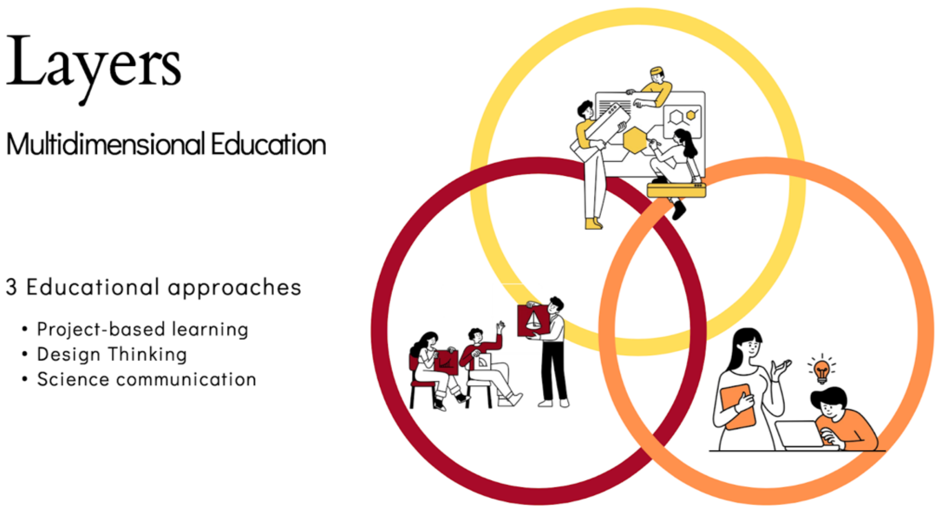

Figure 1: Three layers in the course.

For the Design Thinking process, we follow the 6-step-model from the d-school at Hasso-Plattner Institute with the following parts: Understand, Empathize, Define, Ideate, Prototype, and Test, see Fig. 2 (Meinel & Leifer, 2020). The first two steps, 'Understand' and 'Empathize,' are crucial to understanding the challenge or the problem deeply. The students also reflect about their own point of view and their disciplinary background to be aware about the lenses they are looking at a challenge. So, students should collect diverse data and insights in this step to get a broad overview and a deep understanding of the topic at hand (Brown, 2008; Tschimmel, 2012).

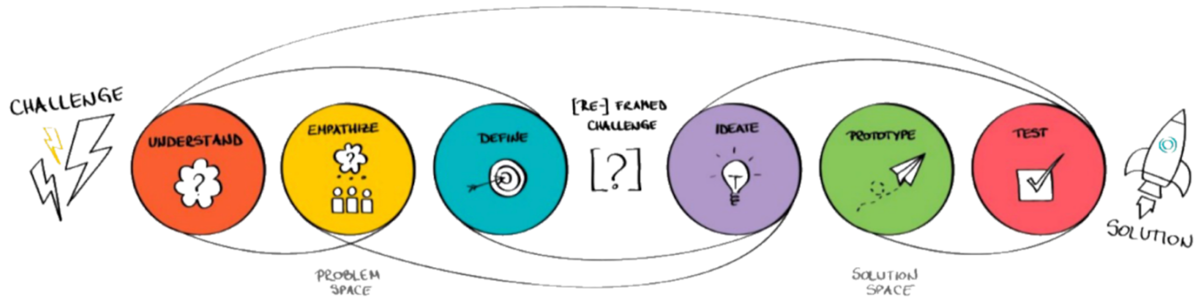

Figure 2: Design Thinking process. Adapted from HPI (Brown, 2008; Meines & Leifer, 2020).

To bridge the gap between the ‘Understand’ and ‘Empathize’ phases and the subsequent stages of Design Thinking and to equip students with tools for managing diverse information, we provide them with the skills to create clear and concise communication materials. The process begins with expert input and lectures on challenges in the South African living lab, followed by extensive information gathering on science communication in small student groups. This approach transforms the complex insights gained during the 'Empathize' phase – from interviews with South African stakeholders, online research, and expert exchanges – into a clear and digestible problem statement for all participants. The students need to critically evaluate the quality of their research information pieces and make sense of them to extract a well-defined problem statement from a diverse number of single insights as a next step. A challenge here is also to unpack the insights every student got and collaboratively work on a clear problem statement, which will serve as a guiding sentence for the solution space (ideate, prototype, and test phases). This process ensures everyone has a shared understanding of the challenge before moving towards solution-oriented phases (Beligatamulla et al., 2019). In the 'Empathize' phase and the subsequent 'Define' phase, we focus on the problem itself. The goal is to deeply understand both who we are as a collaborative team, to recognize our own perspectives, and to gain a comprehensive understanding of the stakeholders involved. Who are the main actors involved? What are the main needs to focus on? In what environment is this project unfolding? What influences the lived experience in this given context? In these first two steps, the problem or challenge at hand is central. In teaching, we must guide our students to broaden their perspectives, encouraging them to reflect on their own experiences and viewpoints while considering the lenses through which stakeholders view the given challenges. In the 'Ideate' phase, students transition into the solution space, generating multiple ideas based on their insights during the first phases in a short time. Following this, a prototype is selected, worked out, and tested. Design Thinking is of an iterative nature. If the students feel the need to better understand the context during the process for example, they might need to go back to the empathise phase and conduct further investigation. The mindset of growing personally by undergoing the Design Thinking process back and forth and learning from failure in early prototypes, and tests is one of the founding principles of this approach.

Science communication as a further competence layer in the course

In addition to the Design Thinking process in the project-based learning environment, the course emphasizes developing science communication toolkits tailored to diverse target audiences. Communicating complex scientific concepts to diverse audiences, including non-experts, remains a significant challenge in academia. By focusing on science communication, the course aims to bridge this gap. Offering science communication training to agriculture and environmental students, provided by the edumedia team of ETH, is essential for reaching a wide range of audiences and fostering food system transformation. These courses enable students to translate complex scientific concepts into accessible and engaging information, making it easier for stakeholders – such as policymakers, farmers, and the public – to understand and act. By enhancing their communication skills, students can develop tools for a better understanding and application of sustainable practices, support innovative solutions, and drive meaningful change in food systems, ultimately contributing to a project aiming for a more resilient and sustainable future.

In class, we reflect on the quality of their insights and mirror them back to the collaborators in South Africa to make sense of the insights in the light of the culture of our partners in the global south. Similarly, during the testing phase, it's important to creatively position the prototype within a communication framework that effectively engages feedback providers. Science communication can be integrated into the Design Thinking teaching approach in a deliberate way and enriches the transferable competencies fostered in this course further.

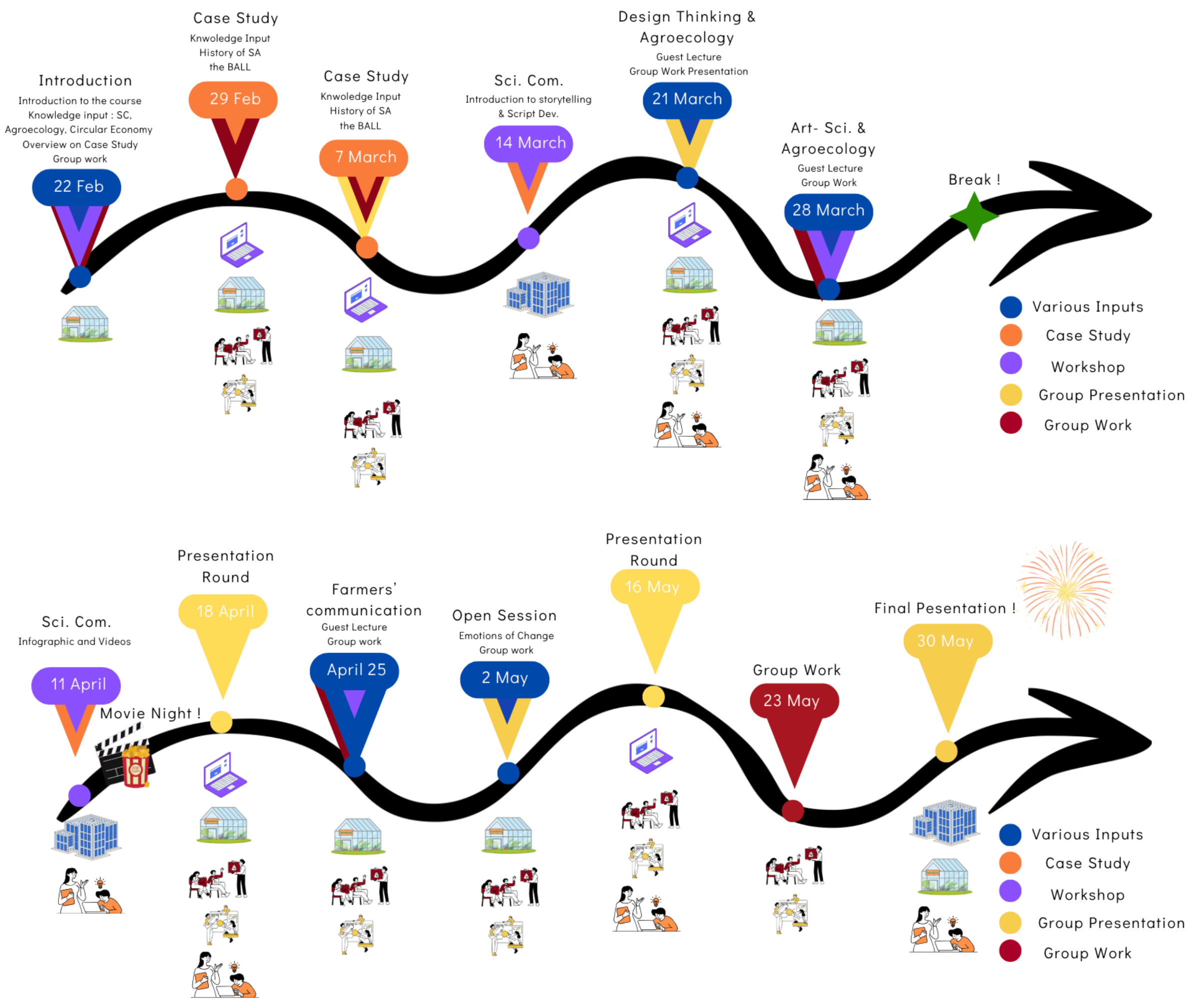

Figure 3: Overview of the course structure.

3. Fostering and assessing transferable competencies with a focus on critical thinking and creativity

Creativity through criticality

Two of the primary competencies fostered during this course were critical and creative thinking. Design Thinking as a teaching method supports critical minds in various ways. In the first step, *Empathize*, students need to critically evaluate how to approach their challenges. Who can be a valid interview partner to understand the needs of the stakeholders better? Compared to all insights in the *Empathize* phase, what does the information tell us about our own assumptions and the reality we have approaches a bit closer? Students need to come up with creative solutions about how to dig deeper into the topics at hand. About whom to approach for an interview or survey and in coming up with innovative ideas about solutions based on the identified needs of the stakeholders. Sometimes it can be hard to leave your own assumptions and solutions in mind behind you and train to be open to perspectives of people involved in a certain challenge.

To be competent in critical thinking is an important indicator of both academic and professional success (Castaño et al., 2023). To foster critical thinking and creativity in higher education, it is essential to set learning goals and plan activities and assessments that centers them both (Reynders et al., 2020) instead of leaving them develop accidentally. The ETH competence framework displays the wide variety of transformative competencies that should be fostered throughout a study program. To reach the goals in this competence area, study programs need to involve the lecturers to systematically integrate transferable competencies in the curricula. Focussing on Critical Thinking, the ETH competence framework[2] defines this as a personal competency and as ‘the ability to analyse and evaluate situations and recommend courses of action.’ However, a crucial aspect often overlooked in this definition is questioning normalized narratives. Critical thinking involves multiple layers of integration, discernment, and the ability to think beyond surface-level understanding, and this ability needs to be trained. In the course ‘Agroecologist Without Borders’, we build upon Bell Hooks’ perspective: ‘Critical thinking involves first discovering the who, what, when, where, and how of things – finding the answers to those eternal questions of the inquisitive child – and then utilizing that knowledge in a manner that enables you to determine what matters most.’ (Hooks, 2010, p 9). Design Thinking as the underlying teaching method, builds upon the mindset of understanding the needs and perspectives of the stakeholders and then prototype and test artifacts that are of high relevance to the challenge in focus. The Design Thinking process enables a growth mindset and a culture of learning from mistakes and, digging even deeper into topics, and understanding perspectives of others even better to get prototypes that are relevant, innovative and a good fit to the challenges at hand. Creativity and critical thinking are, therefore, to be constantly encultured in a Design Thinking learning environment, and students have a great opportunity to train these competencies with their peers and with the lecturer in the position of a guide at the side.

Given the fast pace of the semester, the layered structure of the course, and the substantial workload assigned to students, this course aimed to create space for these curious questions to emerge and unfold. In this regard, the classroom setting and associated processes are crucial. Research suggests developing critical thinking requires integrating theoretical knowledge with professional practice (Bezanilla et al., 2019). This is where project-based learning becomes crucial, preparing students for professional life by making them service providers for the projects presented. In real-world projects, students can apply their theoretical knowledge and integrate perspectives from their learning environment in class and the project stakeholders while also practicing the ability to anticipate the consequences of their actions and positions within the project.

Creative Thinking is described in the ETH competence framework as ‘the ability to produce and implement novel and useful ideas.’ For our course, creative thinking is closely linked with imagination, which is central to the ideation process of design thinking. Here, imagination serves to transcend the confined limits of dominant narratives. As Bell Hooks states: ‘Imagination is one of the most powerful modes of resistance that oppressed and exploited folks can and do use.’ (Hooks, 2010, p 62). Imagination serves a crucial role in fostering critical thinking, enabling individuals to transcend existing paradigms and co-create new ways of understanding, comprehending, and being. While it can push students beyond their comfort zones and sometimes be overwhelming, this process is essential for developing the discernment needed to navigate knowledge and context effectively. Imagination supports critical thinking by challenging normalized narratives and encouraging deeper inquiry. This journey involves constructing well-founded arguments and developing the ability to critically assess various perspectives. Consequently, students are better equipped to adapt and respond to complex situations in an informed manner. In this process, the teacher plays a significant role (Sasson et al., 2018). If students experience a lecturer to take a stance, explicate the own viewpoint and feed well thought arguments into discussion and hear other perspectives, students are likely to feel encouraged to also develop and advocate for their own standpoint as well as develop and discuss their arguments with their peers.

Fostering creative and critical thinking: Insights from student feedback

To foster creative and critical thinking deliberately in class, it is essential to provide diverse tools and environments that encourage questioning, reflection, and creation. In this course, several elements were implemented to achieve this goal. Each session began with a 15-minute reading from a chapter of Bell Hooks’ book, with topics selected based on recent discussions

[2] ETH Competence Framework retrieved from www.ethz.ch/comp-teachingstaff

or upcoming lecture themes. Additionally, resources such as books, links, and insights were shared in the course reader, on Moodle, or in a small library gathering books and diverse literature, all as tools to enrich the learning experience.

The effectiveness of these methods is reflected in the students' feedback. The unique classroom setting was highly appreciated, as one student noted, 'Holding class in the Greenhouse offered a refreshing energy for learning and made group/class work engaging.' Another student echoed this sentiment, stating, 'The greenhouse is a very amazing learning space!' The interactive nature of the course was also highlighted: 'I liked the instructiveness of it, and we saw your engagement. We felt like you were invested in the course and were thinking about how to improve it and how to make us feel better.' Students valued the safe environment for exchange and critical reflection: 'The lecture in the Greenhouse and the number of students provided a safe environment for exchange and critical reflection. In my opinion, the conditions couldn't have been better. I really enjoyed this type of lecture and found it very enriching.' These testimonials underscore the importance of creating a supportive and dynamic learning environment that facilitates both creative and critical thinking.

Assessing process vs. outcome

In Design Thinking, the iterative aspect of prototyping serves as a medium for constant adjustment, ensuring that the outcomes are tailored to the target audience. This iterative process involves multiple steps to refine the prototype, which can sometimes be overlooked, potentially leaving students frustrated if they perceive the lecturer as only outcome-focused. However, the process itself is fundamental, and these exchange sessions are crucial for emphasizing its importance. The process serves as the glue that unifies the various components of the course and acts as a driving force for continually improving quality. Alternative assessment methods, such as rubrics, have the potential to support students not only in planning their projects but also in reflecting on them (Reynders et al., 2020). By engaging in these iterative and reflective practices, students develop a deeper understanding of both the content and the methodologies, fostering a more comprehensive and critical approach to learning.

As Bell Hooks emphasizes, 'critical thinking is an interactive process, one that demands participation on the part of teacher and students alike.' (Hooks, 2010, p 9). In this regard, a strong emphasis is placed on process-oriented approaches, both for learning activities as well as for the assessment methods in the course. This becomes evident in the regular in-class exchanges where students share their progress, insights, and needs with the learning team. The frequency of these encounters underscores the transformative nature of processes rather than focusing solely on the final outcomes presented at the end of the course. Moreover, we developed a rubric to assess critical thinking and creativity objectively and learning-oriented (Reynders et al., 2020). Rubrics are evaluation grids that explicate and ease the assessment process, for example, for oral presentations, lab works, grading a thesis. As the criteria are clearly communicated to the students through the rubric grid, assessment gets more objective. The lecturer needs to thoughtfully develop an evaluation grid to use for a lot of students and, therefore, get better-informed grades. Once the grid had been developed, it could be reused, adding transparency to the grading practice. The following grid in Figure 4 shows a practical example from the described course. It was used in the oral exams and served as criteria while the students were presenting their prototypes to the audience.

Organization (1pts)	The presentation was clear and well organized
	The group presented the target audience, the topics and the problem they want to tackle
	The group provides clear and comprehensive explanations; reasoning is well-structured and detailed
	The prototype/project was answering the problem chosen by the group
Content/criticality (2pts)	The group understood well the content of the project and is able to display it through their work – Available information / Key elements
	The group interpreted the information insightfully / accurately
	The project outcome meets/answers the problem tackled by the group
Creativity (2pts)	Originality – The Project demonstrates highly original thinking and unique and novel ideas
	Elaboration – the ideas are fully developed with great detail and complexity
	Flexibility – The group show exceptional ability to shift perspectives and approaches
	Risk taking – The group has taken significant creative risks and explores unconventional ideas
	Expression – The group expresses ideas with clarity and impact
Context (1 pts)	The prototype is adapted to the target audience
	The group consistently reflects on own biases and assumptions; adjusts thinking accordingly
	The prototype is adapted to the south African context – more specifically the BALL

Figure. 4: Rubric grid for assessing the students based on the learning goals.

Ultimately, the course enables us to turn students' work into tangible communication tools for the project. Over the past year, the games, posters, zones, and digital platforms have been used on-site and shared with various stakeholders. For instance, the urine-diversion toilets at the Knowledge Centre and the school where the DEWATS center is installed feature infographics and materials that explain the processes of waste valorization aimed at schoolchildren and the broader audience visiting the space.

4. Discussion

Questioning hegemonic narratives

The course's unique setting, which integrates a project based in South Africa and fosters creativity and critical thinking, has sparked significant and challenging debates. One of the primary challenges was that students were initially unfamiliar with the context in which they had to produce their prototypes, mostly science communication materials. This unfamiliarity exposed them to different realities, prompting a process of learning and unlearning various worldviews and contexts.

Transnational collaboration, as implemented in this course, serves to train students in a globalized world. By engaging in such collaborations, students can limit CO2 emissions associated with travel while initiating discussions grounded in concrete projects and needs. This approach has practical challenges, as it sets a degree of discomfort for students in navigating a context they don't know well and requires them to be curious enough to understand the specifics of the context and gain enough understanding of the situation in a short amount of time. However, it also encourages a critical examination of worldviews. The continuous exchange with practitioners, lecturers, and academics centers on non-European voices around questions related to agriculture, food systems, agroecology, and circular bioeconomy in a way that connects the students to other realities. For example, the students were invited to critically examine the colonial legacy of agronomy in the South African system, such as apartheid's impact on food sovereignty and land access. Complementarily, all these inputs highlight the necessity of decentering European/hegemonic narratives in an academic context and offer possibilities to decolonize knowledge and academic practices. It is beneficial for the learning process to make these underlying processes and interconnections explicit and reflect on them deliberately on a regular basis.

Bringing decolonial methodologies

The course facilitated discussions on the hegemonic narratives perpetuated by science and the imperative to decolonize academia, curricula, and ecological practices. Agroecology emerged as a strong proponent of decolonial approaches, emphasizing the importance of indigenous voices being heard and acknowledged. The co-creation of knowledge is fundamental to supporting food system transformation and agroecological transition. This involves developing learning exchanges where farmers, scientists, and students collaboratively analyze and co-develop solutions to implement these agroecological practices. Integrating agroecological principles into curricula emphasizes ecological and social sustainability over exploitative and extractive-focused models, teaching students to work with rather than impose upon local ecologies and knowledge holders.

A decolonial approach to teaching requires not only acknowledging dominant epistemologies that can still be present and infused in our way of relating to one another and the knowledge we bring but also actively creating space for alternative ways of knowing. Engaging with transdisciplinary and community-based methodologies allows students to critically assess their own positionality, biases, and assumptions. Structured reflexivity exercises help students examine their backgrounds, biases, and roles in knowledge production while exploring power dynamics in agricultural extension, development projects, and global agrifood governance.

Decentering Western paradigms fosters deeper engagement with agroecological practices, which often derive from lived experiences rather than only technical expertise. This shift encourages students to think beyond extractive knowledge production and toward reciprocal, situated learning. By integrating decolonial methods into pedagogy, the course not only enriches scientific discourse but also contributes to more just and contextually relevant solutions for food system transformation. This includes shifting away from traditional classroom settings to explore new ways of engaging with the space, the project, the questions raised, its limits, and the ways in which the project is still continuously developing. Encouraging collaborative, non-hierarchical learning structures where students, educators, and practitioners contribute knowledge is essential for this transformation.

Integration of Design Thinking for project based-learning

The integration of Design Thinking into the ‘Agroecologist Without Borders’ course at ETH Zurich has proven highly effective in cultivating both critical and creative thinking skills among students. This approach aligns with the core objectives of agroecology, which seeks to redesign food systems for ecological, economic, and social sustainability. Engaging students in real-world, transdisciplinary projects has created a rich learning environment that bridges theory with practical application. Rubrics as an assessment tool have further enhanced this process, providing students with structured reflection opportunities and offering lecturers a more objective method for evaluating both process and outcome.

One of the key strengths of this course is its emphasis on stakeholder engagement, participatory learning, and intercultural collaboration and exchange. This not only enhances the relevance of the projects but also helps students develop essential skills in science communication and project management. The use of design thinking methodologies, particularly the six-step model from the d-school at Hasso-Plattner-Institute, has been instrumental in guiding students through the process of empathizing with stakeholders, defining problems, ideating solutions, prototyping, and testing. Design Thinking could be beneficial for other teaching contexts as well if there are clear real-world challenges to work on. Design Thinking as a teaching method is beneficial if lecturers aim to integrate domain-specific competencies with transferable competencies like collaboration, creativity, and critical thinking. If the lecturer explicates their own viewpoints and encourages the students to also take a stance and advocate for their perspectives in a research-grounded manner, important competencies like understanding other perspectives better to develop elaborated arguments can evolve and be fostered along the way.

Transdisciplinarity has also been pivotal in shaping the learning environment, exposing students to a wide range of perspectives from societal actors in South Africa, practitioners in the field, and researchers as well as experts in various disciplines (agroecology, science communication, design thinking). This diverse interaction has deepened their understanding of the interconnections between ecological, social, and economic systems, encouraging a more holistic and critical approach to problem-solving within agroecological transitions.

Challenges and ways forward

However, challenges remain. Time constraints and the need for effective online collaboration have posed difficulties. While digital tools like Zoom, WhatsApp, and Miro allowed for continued communication and collaboration, the absence of in-person interaction sometimes hindered deeper engagement. Increasing the opportunities for face-to-face collaboration could have enhanced the learning experience.

Additionally, the course has only 3 ECTS, and if we were to ask students to dive appropriately into the topic, we would need a higher time allocation and thus credits compensation. Mobilizing the experts, practitioners, and users of the science communication toolkit has also been challenging, as we want as much iteration and feedback on the prototyping phase as possible to make the product usable. We know that grasping the attention of people working in the field daily might be challenging.

Despite these obstacles, the course adapted successfully, maintaining its focus on meaningful learning experiences. At the same time, we plant seeds of knowledge and critical thinking in students' minds without controlling when or how they will harvest the benefits of their intellectual growth. The poetic of growth is not linear. In the end, we see this work as just one of the many teaching practices they will encounter throughout their learning journey.

Conclusion

In summary, the 'Agroecologist Without Borders' course has effectively integrated Design Thinking into its project-based learning framework, equipping students with the skills and insights necessary to tackle complex agroecological challenges. The course's emphasis on stakeholder engagement, transdisciplinary collaboration, and participatory knowledge creation has enriched the educational experience and prepared students to be impactful contributors to the field of agroecology.

This innovative approach underscores the importance of fostering both critical and creative thinking in agroecological education. The dynamic and supportive learning environment has empowered students to navigate the complexities of agroecological systems, thereby positioning them to contribute meaningfully to the transformation of food systems. Despite the challenges posed by the transnational nature of the course and the necessity for online collaboration, the course has demonstrated resilience and adaptability. It stands as a model for future iterations, offering a pathway to continued evolution and relevance in response to emerging global challenges.

Bibliography

Beligatamulla, G., Rieger J., Franz J., & Strickfaden M. (2019). Making Pedagogic Sense of Design Thinking in the Higher Education Context. *Open Education Studies*, 1(1), pp. 91–105. https://doi.org/10.1515/edu-2019-0006.

Bezanilla, M.J., Fernández-Nogueira, D., Poblete, M., & Galindo-Domìnguez, H. (2019). Methodologies for teaching-learning critical thinking in higher education: The teacher's view. *Thinking Skills and Creativity*, 33, p. 100584. https://doi.org/10.1016/j.tsc.2019.100584.

Biggs, J., Tang, C., & Kennedy, G. (2022). *Teaching for Quality Learning at University 5e*. McGraw-Hill Education (UK).

Brenner, W., Uebernickel, F., & Abrell, T. (2016). Design thinking as mindset, process, and toolbox. In W. Brenner & F. Uebernickel (Hg.), Design thinking for innovation (S. 3–21). Cham: Springer.

Brown, T. (2008). Design thinking. Harvard Business Review, 86(6), 84.

Castaño, J.P., Arnal-Pastor, M., Pagán-Castaño, E., & Guijarro-García, M. (2023). Bibliometric analysis of the literature on critical thinking: an increasingly important competence for higher education students. *Economic Research-Ekonomska Istraživanja*, 36(2), p. 2125888. https://doi.org/10.1080/1331677X.2022.2125888.

David, C., & Bell, M.M. (2018). New challenges for education in agroecology. *Agroecology and Sustainable Food Systems*, 42(6), pp. 612–619. https://doi.org/10.1080/21683565.2018.1426670.

D.School (2010). Design Thinking Bootleg. Available at https://dschool.stanford.edu/resources/the-bootcamp-bootleg. Hassno Platner & Institute of Design at Stanford University.

Ericson, J.D. (2022). Mapping the Relationship Between Critical Thinking and Design Thinking. *Journal of the Knowledge Economy*, 13(1), pp. 406–429. https://doi.org/10.1007/s13132-021-00733-w.

Francis, C. A., Nicolaysen, A. M., Lieblein, G., & Breland, T. A. (2020). Transformative education in agroecology: student, teacher, and client involvement in colearning. *Ciencia e investigación agraria: revista latinoamericana de ciencias de la agricultura*, 47(3), pp. 280–294.

Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. International journal of educational research, 102, 101586.

Hajriani, S., Elpisah, & Nurdin. (2025). The Effect of Problem-Based Learning (PBL) on Critical Thinking and Social Science Concept Mastery in SMPN 4 Makassar. *International Journal of Social Science and Humanity* 2.1 (2025): 70-85.

Hawthorne, G., Sagger, M., Quintin, E., & Bott, N. T. (2016). Designing a Creativity Assessment Tool for the Twenty-First Century: Preliminary Results and Insights from Developing a Design-Thinking Based Assessment of Creative Capacity. In H. Plattner, C. Meinel, and L. Leifer (eds) *Design Thinking Research: Making Design Thinking Foundational*. Cham: Springer International Publishing, pp. 111–123. https://doi.org/10.1007/978-3-319-19641-1_8.

Hooks, B. (2010) *Teaching Critical Thinking: Practical Wisdom*, *Routledge & CRC Press*. https://www.routledge.com/Teaching-Critical-Thinking-Practical-Wisdom/hooks/p/book/9780415968201 (Accessed: 18 September 2024).

Jia, L., Jalaludin, N. A., & Rasul, M. S. (2023). Design thinking and project-based learning (DT-PBL): A literature review. *International Journal of Learning, Teaching and Educational Research*, *22*(8), 376-390.

Ji Jiang, C., & Pang, Y. (2023). Enhancing design thinking in engineering students with project-based learning. *Computer Applications in Engineering Education*, *31*(4), 814-830.

Lieblein, G., Østergaard, E., & Francis, C. (2004). Becoming an Agroecologist through Action Education. *International Journal of Agricultural Sustainability*, 2(3), pp. 147–153. https://doi.org/10.1080/14735903.2004.9684574.

McLaughlin, J. E., Chen, E., Lake, D., Guo, W., Skywark, E. R., Chernik, A., & Liu, T. (2022). Design thinking teaching and learning in higher education: Experiences across four universities. *PLOS ONE*, 17(3), p. e0265902. Available at: https://doi.org/10.1371/journal.pone.0265902.

Meinel, C., & Leifer, L. (eds) (2020). *Design Thinking Research: Investigating Design Team Performance*. Cham: Springer International Publishing (Understanding Innovation). https://doi.org/10.1007/978-3-030-28960-7.

Pohl, C., Pearce, B., Mader, M., Senn, L., & Krütli, P. (2020). Integrating systems and design thinking in transdisciplinary case studies. *GAIA - Ecological Perspectives for Science and Society*, 29(4), pp. 258–266. https://doi.org/10.14512/gaia.29.4.11.

Reynders, G., Lantz, J., Ruder, S. M., Stanford, C., L., & Cole, R. S. (2020). Rubrics to assess critical thinking and information processing in undergraduate STEM courses. *International Journal of STEM Education*, 7(1), p. 9. https://doi.org/10.1186/s40594-020-00208-5.

Sasson, I., Yehuda, I., & Malkinson, N. (2018). Fostering the skills of critical thinking and question-posing in a project-based learning environment. *Thinking Skills and Creativity*, *29*, 203-212.

Tschimmel, K. (2012). *Design Thinking as an effective Toolkit for Innovation*. In ISPIM Conference Proceedings (p. 1). The International Society for Professional Innovation Management (ISPIM).