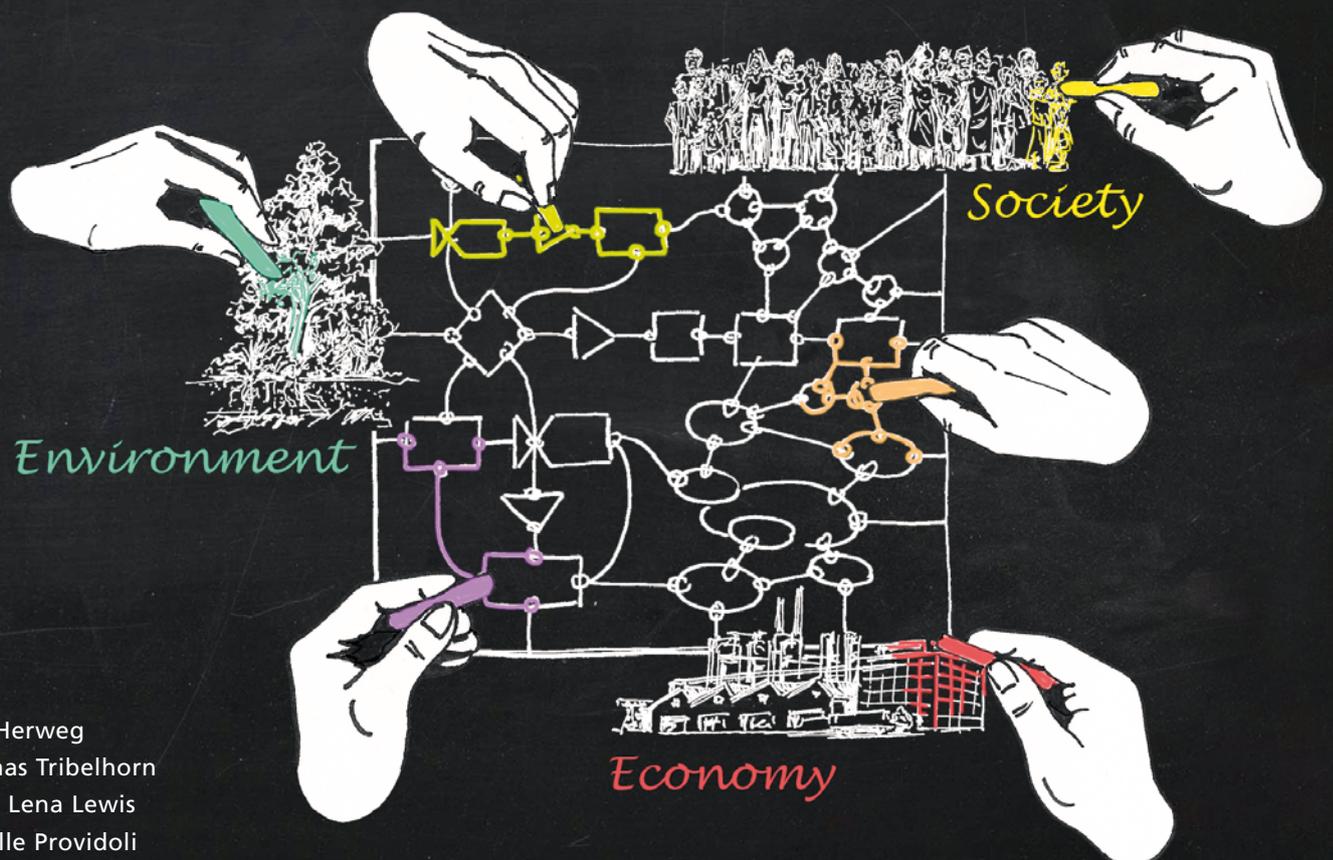


# Transdisciplinary Learning for Sustainable Development

SHARING EXPERIENCE IN COURSE AND CURRICULUM DESIGN



Karl Herweg  
Thomas Tribelhorn  
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## QUICK GUIDE

### Guiding Questions for Designing Transdisciplinary Learning

1. What are potential **links** between your discipline and **SD**?
2. What **fields of work** will the graduates enter?
3. What **typical situations** will students have to **master** within these fields of work?
4. What **competences** do students need to master these situations?  
At the end of the programme / course ...
  - ... What do they know (**academic knowledge**)?
  - ... What can they do (**professional skills**)?
  - ... What are their attitudes and values (**critical awareness**)? What **factors** promote **critical awareness** in SD?
5. What are the **basic organizational conditions** of the course, in terms of both teaching and target group?
6. **Constructive alignment**
  - ... What are the intended **learning outcomes**?
  - ... What **learning activities** will help students to achieve these learning outcomes?  
What learning environments and teaching–learning arrangements support creating spaces for transformative moments?
  - ... How will you assess whether students have achieved the learning outcomes? What **assessment** formats help to determine incremental achievement of the intended competences?
7. How and when will you **evaluate** the **effectiveness** of the teaching–learning arrangements and teaching strategies? What transformative moments could appear during the course?

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## Imprint

*Transdisciplinary Learning for Sustainable Development – Sharing Experience in Course and Curriculum Design* is a book aimed at university lecturers of all disciplines. It addresses people who want to incorporate sustainable development into individual university courses, modules, and/or entire study programmes. Drawing on the authors' wealth of practical experience at the University of Bern, the book also serves as a crash course in sustainable development (SD) and education for sustainable development (ESD).

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## Foreword

This book deserves an enthusiastic foreword. As Vice-Rector for Quality at the University of Bern, I have also been in charge of Sustainability and Sustainable Development since 2017. My predecessor in this position and dear colleague, Prof. Dr. Doris Wastl-Walter, laid excellent foundations for strengthening the university's focus on Education for Sustainable Development (ESD) in particular. Drawing on our university's existing resources and competences, as well as the expertise of a competent team from the Centre for Development and Environment (CDE) for the university-wide strategy and work in ESD, proved to be a wise decision. Goals were set, e.g. that no student should leave the university without a double lesson in how their subject is linked to Sustainable Development. Incentives were created, e.g. university resources to promote topics and aspects of Sustainable Development in courses of all subjects. Over several years, measures were developed, evaluated, and improved. For me, discovering what ESD really entails has been an enriching experience of "learning by doing". Working with the ESD team has been characterized by collegiality, competence, and creativity, and I am extremely pleased at how this wealth is reflected so uniquely in this publication in increasing the visibility of ESD and making it accessible to a wider audience. In some respects, the publication may be a snapshot of our time, but in its richness it should also be considered a repository or a collection. This is a textbook that is informative, inspiring, and never boring – it is a firework of knowledge, ideas, suggestions, and examples of transdisciplinary learning in its many facets.

How do we – as individuals, as a society, and globally – move from knowledge and science to action, after decades of striving for "growth" that has manoeuvred our planet and its inhabitants to the edge of a dangerous abyss? How do we transform our knowledge – which by now is very good and extremely detailed – on the causes of climate change into social action and civic responsibility? As a theologian, I have learned to question Christian "beliefs", which are only "believed", and to examine them for their relevance and their ability to stand the test of time. Questioning "knowledge" that is only "known" in light of how today's research can power change is a comparable endeavour. The words "science" and "conscience" have a connection that must be redeemed ethically.

This book provides – at the highest level of expertise in sustainability as well as in pedagogy and didactics – courage for joint thinking and action for transdisciplinary learning and teaching. It is simultaneously practice-oriented and groundbreaking in terms of science and action theory. And last but not least, Karl Herweg's cartoons allow us to view the situation – in all its seriousness – from a somewhat different perspective, and thus to make the readers laugh, hopefully also at themselves. As some of the drawings show, the venerable university, in the face of great challenges, has to go with the flow – and get wet in the process. But not just the university alone.

I sincerely thank the team of authors and wish this publication a sustained uptake and that it will lead to many fruitful discussions. Above all, I wish this publication many enthusiastic users.

Prof. Dr. Silvia Schroer  
Vice-Rector for Quality  
University of Bern

## About this book

Education can play a key role in advancing transformations to more sustainability. While this is widely acknowledged under the heading of ESD – Education for Sustainable Development – many lecturers are still unsure of what they themselves can do to promote ESD. This book provides inspiration and answers. We aim to show that if you're a lecturer at a university or other higher education institution, there is so much you can do!

This book is an interdisciplinary co-production by six authors at the University of Bern, Switzerland. Some of us are trained teachers, one of us is a Learning Psychologist, and some of us are Geographers. Just like many lecturers, some of the Geographer authors of this book started out with no pedagogical background. What we do have is a wealth of experience in ESD, gained through our courses and study programmes at the University of Bern – but also in our partnerships of research and education in the global South.

Around the turn of the millennium, the Centre for Development and Environment (CDE) at the University of Bern – together with its partners in Switzerland, Asia, Africa, and South America – chose “transdisciplinarity” (td) as its main approach to research for sustainable development (SD). In CDE's td approach, interdisciplinary teams of scientists work closely with various societal actor groups, to find joint solutions to real-world problems. Td can thus be considered a process of social learning, and it enabled us to gain extensive teaching experience in various sustainability contexts. In this book, our expertise in one area of specialization, Sustainable Land Management, serves as an example to concretize and illustrate didactic procedures in an ESD context.

Educational sciences have long provided empirical research results for improving higher education. The literature contains an array of theories, approaches, models, and tools representing various debates in different schools of thought, movements, and communities of practice. Lecturers and experts in other subjects have little chance of keeping up with and incorporating even the most important of these insights. In some cases, we may not even understand the pedagogic jargon. In planning our courses, we need to select the tools that seem to best fit our topics and our teaching. Invariably, we choose from the selection available to us – meaning that in all likelihood, many highly relevant pedagogical findings remain unknown to us. We are probably not alone in this situation, which is a consequence of disciplinary structures in current academic institutions.

Within the University of Bern, the CDE team gradually established a close cooperation with teaching specialists, in particular with the Educational Development Unit. Together we decided to write this book as an interdisciplinary team, focusing on educational research theories, recommendations, and proven tools – and combining them with our practical experience. Our aim is not to provide an extended literature review or to analyse the limitations and potentials of a broad array of approaches. Instead, we focus on didactic approaches, methods, and tools that we have applied in our teaching over a longer period, and that we found useful and applicable in our context. We also share the new tools to design ESD courses and curricula that our interdisciplinary collaboration spawned.

The purpose of this book, therefore, is to share this experience in both the global North and South. Since we are convinced that all disciplines can contribute significantly to SD, our goal is to encourage lecturers to incorporate ESD in innovative teaching–learning arrangements. This is a tremendous challenge ahead of us.

# Finding your way in this book

The following elements complement the main text of the book:

**Messages** summarize the text in a nutshell



**Reflection** boxes invite you to reflect on certain issues



**Examples** illustrate concepts and theories



**Bookshelves** at the end of each chapter refer to cited references



## Cartoons

This book contains cartoons drawn by one of the authors, Karl Herweg, who is also a scientist. We invite you to view these cartoons in any number of ways. Either as mere entertainment or as a visual break from the text, perhaps appreciated simply as art, for their creativity, or for their wit. Or, you can position them in an *art-science nexus*, using them as an eye-opener, an opportunity to see things from a new perspective, a different gateway to reflect on statements and debates mentioned in the book. Whether or not you agree with the messages of the cartoons, we hope you enjoy exploring their meanings and your reaction to them.

## List of acronyms

ESD	Education for Sustainable Development
HDI	Human Development Index
id	Interdisciplinarity, interdisciplinary
SD	Sustainable Development
SDG	Sustainable Development Goal
SES	social-ecological systems
td	Transdisciplinarity, transdisciplinary
TL	Transformative Learning
UN	United Nations

## Acknowledgements

Establishing Education for Sustainable Development (ESD) across faculties and institutes requires many dedicated colleagues and the building of alliances. We owe a great debt of gratitude to Prof. Dr. Doris Wastl-Walter and Prof. Dr. Silvia Schroer, former and current Vice-Rector for Quality at the University of Bern, for their continuous and strong encouragement and support for institutionalizing and mainstreaming ESD and making it a long-term endeavour. We are also grateful to Prof. Dr. Bruno Moretti, who promoted the development of innovative learning scenarios for ten years, as Vice-Rector for Teaching and Learning at the University of Bern until the summer of 2021. Further, our great appreciation goes to the growing number of committed lecturers and interested staff of the three higher education institutions in Bern: the University of Bern, Bern University of Applied Sciences (BFH), and Bern University of Teacher Education (PHBern) for their stimulating discussions, continuous collaboration, and numerous contributions that help to put ESD into practice. Finally yet importantly, a big thank you goes to all our students who are open to experiencing new teaching–learning formats and give us their frank and honest feedback

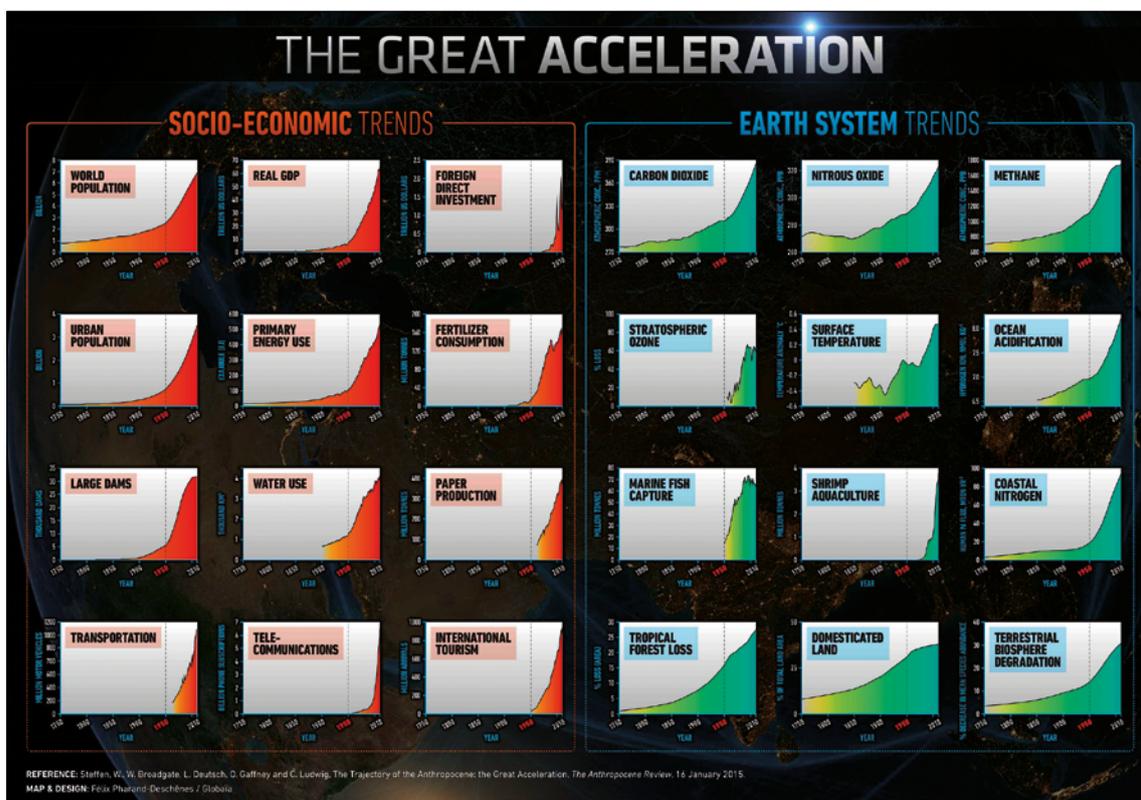
What is your motivation to incorporate SD into your teaching?  
What do you hope to learn by reading this book?



# 1 How Can Science and Education Help Shape Sustainable Development?

## 1.1 The Anthropocene and the Great Acceleration

Since the Industrial Revolution, humans have become the main shapers of our earth's ecosystem. The 1950s saw the start of a great acceleration in many socio-economic and earth system trends (Figure 1), prompting calls to coin the current geological era the "Anthropocene". Human activity frequently results in *complex changes* that proceed *rapidly* (temporal aspect) and spread *globally* (spatial aspect). Changes may have *negative* and/or *positive* effects that vary over time and create both winners and losers. The globalized economy is a major driver of problematic or unsustainable development with detrimental effects, such as global warming, pollution, environmental pollution, biodiversity loss, food waste, armed conflicts, and flows of refugees.

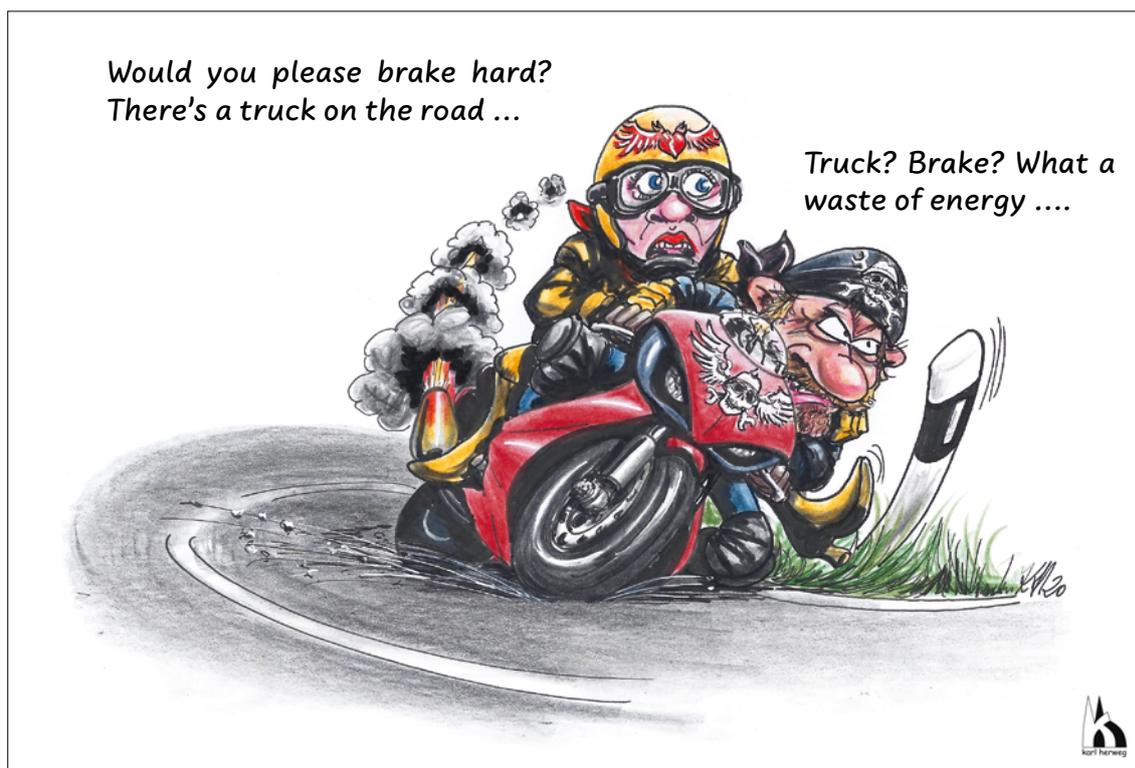


**Figure 1:** Selected socio-economic and earth system trends since 1750 (Industrial Revolution), with a great acceleration since the 1950s (Source: Steffen et al. 2015)

The risks of globalization were impressively laid bare by the COVID-19 pandemic, which, within a very short time, significantly disrupted all aspects of life as we knew it.

In the **Anthropocene**, humans became the most significant impact factor on the earth's ecosystem. Since the 1950s, the Anthropocene is characterized by a **great acceleration** of both global ecological and socio-economic trends. Our ability to do seems to have outstripped our ability to understand what we are doing!





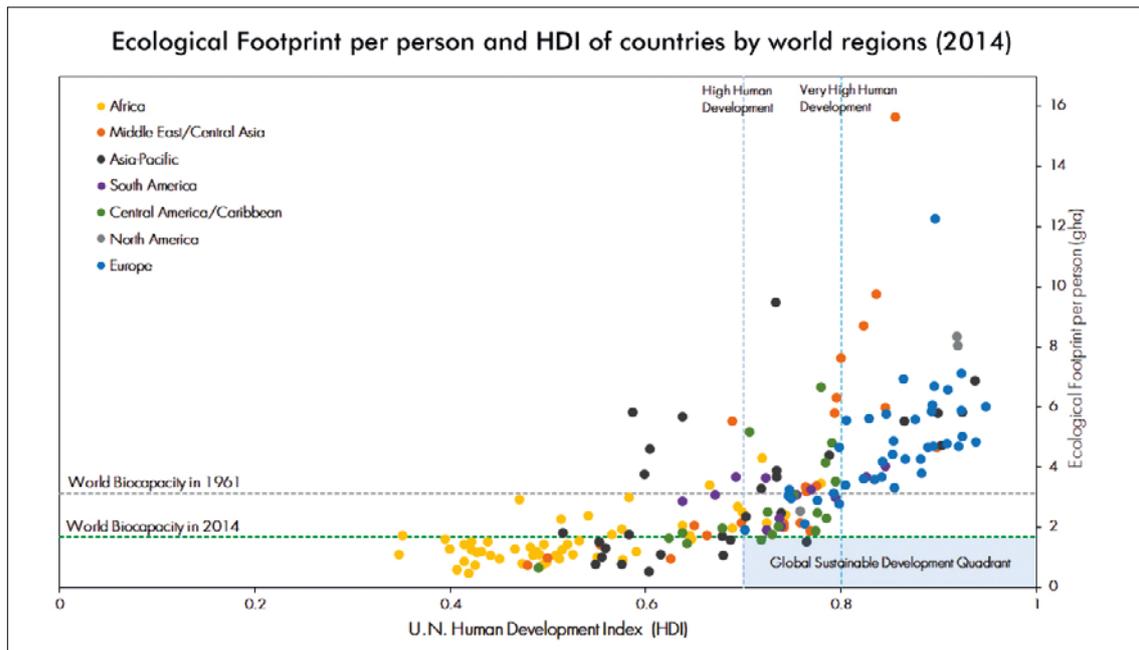
**Cartoon 1:** The Anthropocene – the great acceleration (Illustration: K Herweg)

Current development trends in the Anthropocene seem to be increasing rather than reducing existing global socio-economic disparities, a spatial aspect that is revealed by combining two indicators of global unsustainable development (Figure 2). The “Ecological Footprint” represents natural resource and energy use. It is expressed as the area (in global hectares per year) one person needs to maintain their current lifestyle and living standards in the long run, including the area for production of food, clothing, energy, waste disposal, carbon sequestration, etc. (Global Footprint Network 2003–2021). The “Human Development Index (HDI)” is a national human welfare indicator, representing the socio-economic basis for development. It includes gross domestic product, life expectancy, and probable duration of education per person (UNDP 2021).

About 20% of the world population – mostly industrialized countries in Europe, North America, and the Middle East – currently consume about 80% of the earth’s natural resources. This means that only a change in energy consumption patterns in those countries will lead to a significant reduction in global natural resource and energy use. Only such a change will help to maintain ecosystem services for future generations. At the same time, the socio-economic basis of many people is insufficient and inhumane, particularly – but not only – in developing countries, among them almost all African countries. Such disparities contradict the UN demand for global equity and justice; they are also at the root of destabilizing processes such as armed conflicts, migration, and flows of refugees.

Today, human activities commonly result in **complex changes**, i.e. changes that affect all three sustainability dimensions (environment, society, and economy). Changes are often **rapid** and spread **globally**, exacerbating existing socio-economic disparities. Changes may have **negative** and/or **positive effects** that may vary over time, creating both winners and losers. The global disparities in wealth and natural resource use clearly point the way: **reduce energy and resource waste** in the industrial countries; **improve the socio-economic basis** in the developing countries.





**Figure 2:** The combination of Human Development Index and Ecological Footprint reveal global socio-economic disparities (Source: Lin et al. 2018, 58)

Already half a century ago, the “Meadows report”, *The Limits to Growth*, predicted:

“If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years. The most probable result will be a rather sudden and uncontrollable decline in both population and industrial capacity.” (Meadows et al. 1972, 23).

Since then, various milestones in the literature have created broad awareness of the major global challenges, including suggestions on how to deal with them. For example, *Our Common Future* (WCED 1987); the UN “Rio” Conference on Environment and Development 1992 with its Agenda 21; the *United Nations Millennium Declaration* and the Millennium Development Goals or MDGs (UNGA 2005); and *2052: A global forecast for the next forty years* (Randers 2012). In September 2015, the *UN Agenda 2030 for Sustainable Development* was approved by 193 member states (UNGA 2015). Entitled “*Transforming our World*”, it contains the Sustainable Development Goals (SDGs) and is thus *the* globally accepted political agenda for SD in the coming years.

Knowledge on the unsustainability of impending developments has been around for half a century, with a first early warning published in 1972 “(*The Limits to Growth*)”, followed by several other milestones in literature, many of them based on research. The latest milestone – the *UN 2030 Agenda* with its 17 SDGs, is **the globally accepted political agenda** for SD in the coming years.





**Cartoon 2:** Limits to Growth – how to convince a tumour that what it considers a great success is in reality tantamount to suicide? (Illustration: K Herweg)

## 1.2 The UN Understanding of “Sustainable Development” and the Role of Science

The UN understanding of “Sustainable Development” (SD) serves as an orientation, postulating a development that *“meets the needs of the present without compromising the ability of future generations to meet their own needs”* (WCED 1987). SD is a long-term, optimistic mission statement of societal development that puts people and their needs, capabilities, and actions at the centre. It simultaneously strives for inter- and intra-generational, sociocultural, and economic equity and justice, and to maintain the functions of nature and the services it provides to society.

These tasks require contributions at all levels of decision-making, from the individual to the global. Consequently, participation is one of the core principles of the vision. But SD is a fuzzy target, and solving complex problems is a continuous process of negotiation to identify trade-offs (compromises); to balance and harmonize multiple ecological, sociocultural, and economic interests; and to solve target conflicts in consensus and peacefully. A precondition of this process is that all actors are empowered with the necessary knowledge, skills, and critical awareness (i.e. attitudes and values) to act and contribute accordingly. This requires research, education, and suitable institutional conditions that enable people to focus on SD. We consider SD a continuous global and societal process of searching, learning, and shaping. International collaboration has led to the globally agreed UN 2030 Agenda. This is promising. But even though the SDGs are set, implementing them still requires a negotiation of trade-offs at all levels.

The obvious question, then, is what can we do? We have three options:

- **We let evolution run its course:** We take a business-as-usual approach, ignoring indicators of unsustainable development. Eventually, we find ourselves in a dead-end road with no way of turning or reversing – and with disastrous consequences for the entire planet.
- **We reform the system:** We envisage sectoral changes, e.g. in managing natural resources, optimizing fuel consumption, insulating houses, avoiding food waste, etc., without questioning the prevailing global “system”. “System” here refers to the current, global, economic utilization of natural resources by society. It is unclear, however, whether changes *within* the system are enough to save the planet or whether they remain merely cosmetic.

- **We transform the system:** If reforms *within* the current system are considered insufficient, there is a need to discuss a transformation, a specific type of social and institutional change *within* and *of* the system, which is knowledge- and evidence-based rather than opinion- and ideology-based.

While these options are currently under debate, numerous scientists (e.g. WBGU 2011) suggest a “Great Transformation”. We should also bear in mind that the subheading of the UN 2030 Agenda and the SDGs is “transforming” our world, not reforming it!

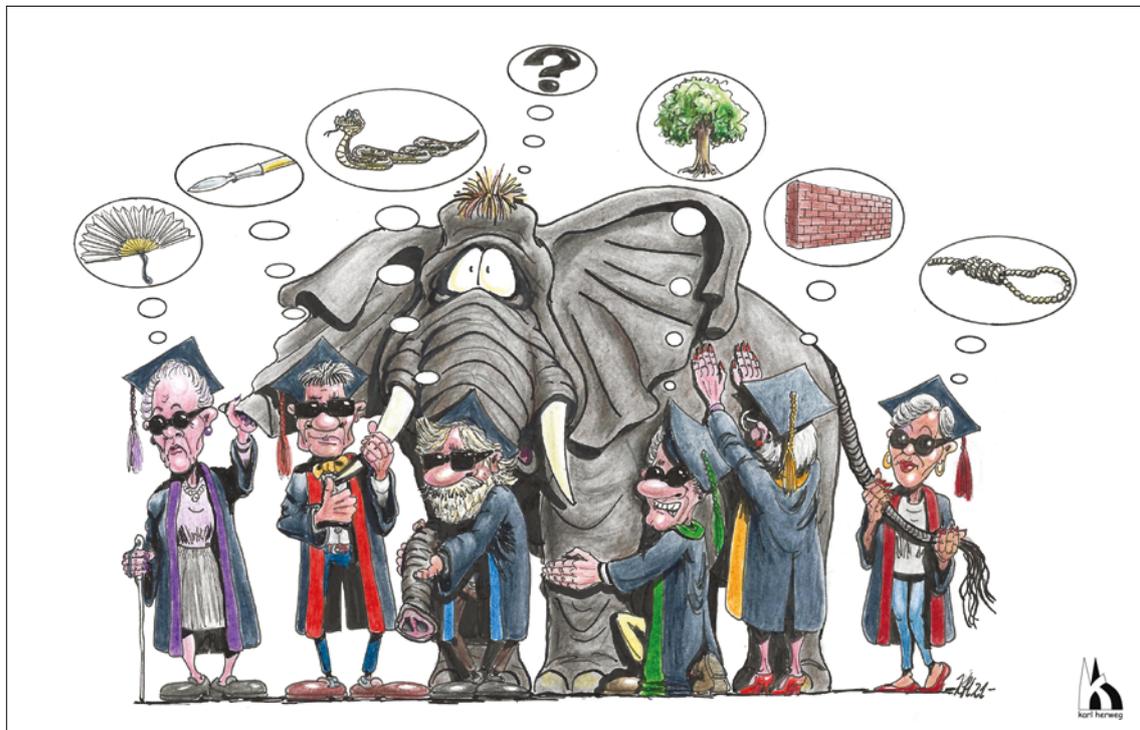
According to the UN understanding, the main goals of SD are socio-economic equity and justice while using natural resources respectfully. SD is a process of **searching, learning, and shaping**, and requires the participation of all actors. Their knowledge and empowerment should be based on **research** and **education**.



### 1.3 Sustainability Science: Transdisciplinary Research for Sustainable Development

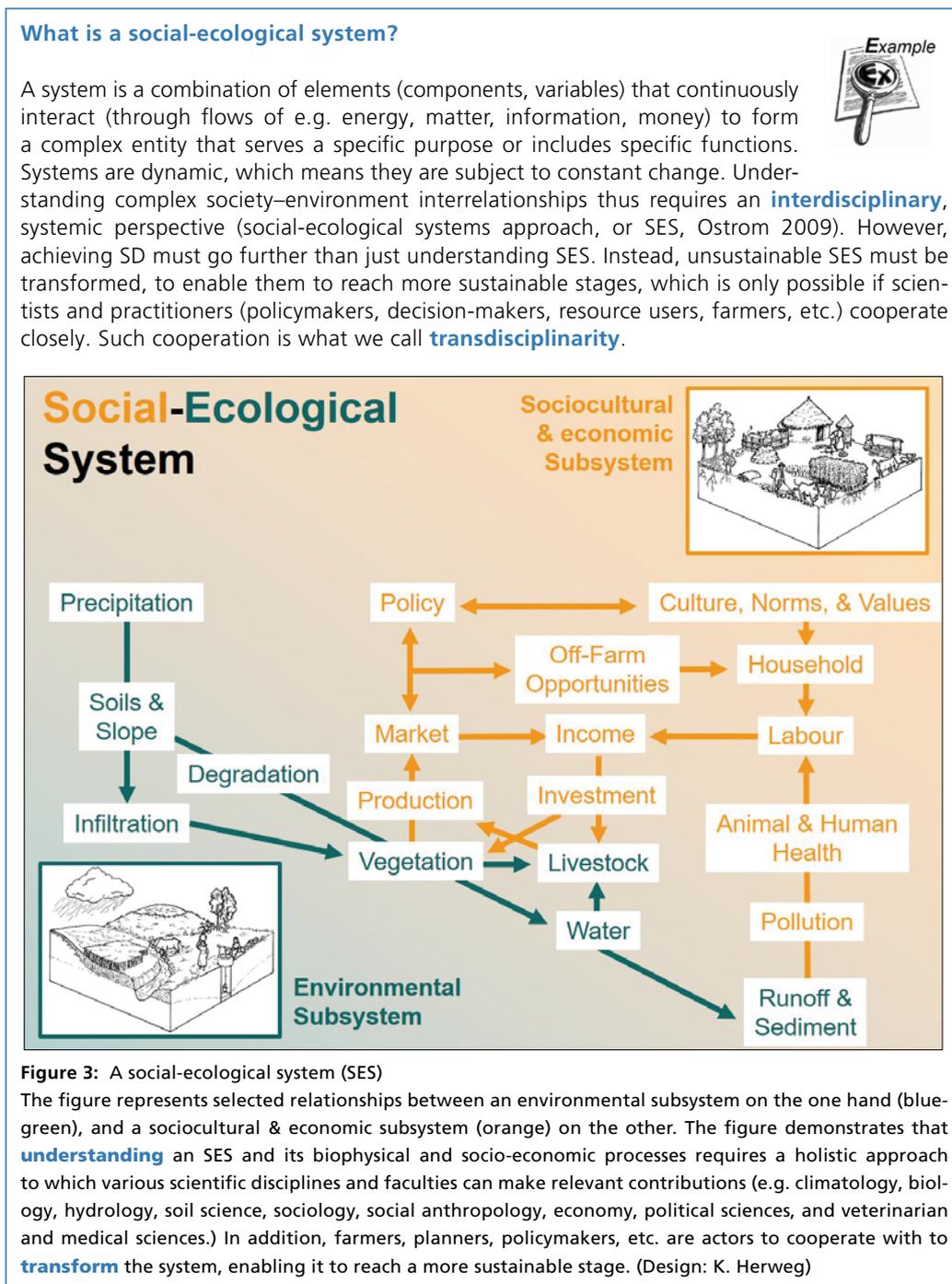
Aspects of global unsustainable development, such as climate change, biodiversity loss, poverty, etc. are often identified or verified by research. What do scientists do with these findings? Do they leave policymakers and other actors to interpret research results and draw their own conclusions, or should science assume more responsibility, for instance, by devoting certain activities to help mitigate complex global problem settings? The following argues what type of science and research supports SD, and further, what type of education supports sustainability science. This is not a literature review. Instead, as the title of this book suggests – we are *sharing our experience* in course and curriculum design. We therefore focus on two main approaches that we have applied and that reflect our long-term experience: transdisciplinary research and transformative learning.

Scientific research options may be “disciplinary” (involving a single discipline), “interdisciplinary” (in cooperation with other disciplines), or “transdisciplinary” (different disciplines working with the participation of various stakeholders from practice).



**Cartoon 3:** Disciplinary science and complex realities (Illustration: K Herweg)

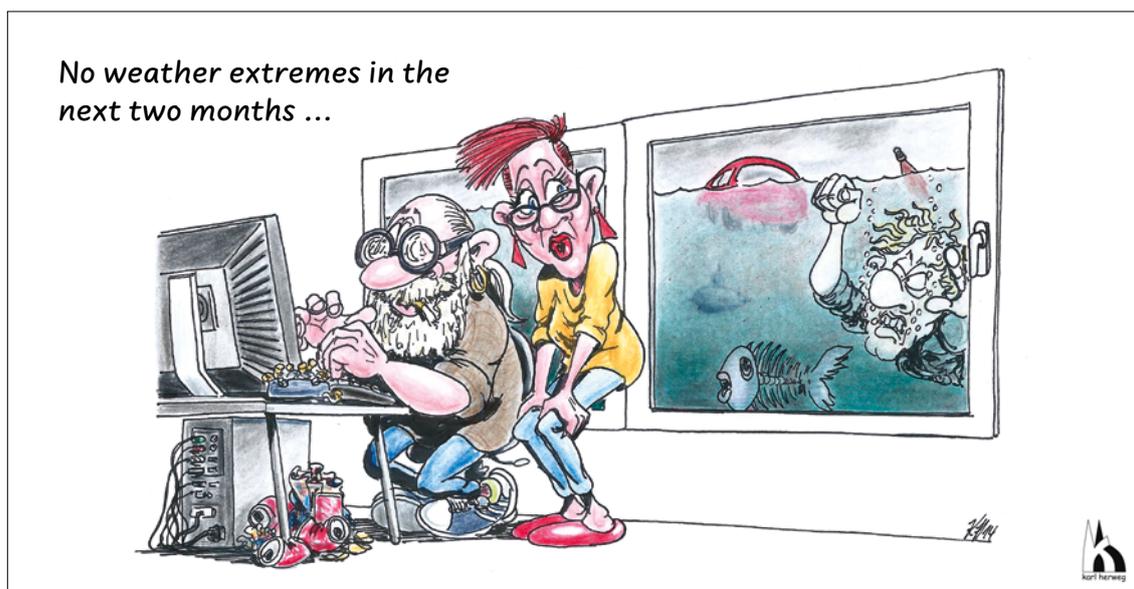
Many research findings can make a relevant contribution to SD. But a disciplinary approach may conceal detrimental side-effects that are taking hold elsewhere – such as in other parts of the same system. This is why a “systems approach” is needed, as illustrated in Figure 3 for “social-ecological systems”. Achieving SD involves sociocultural, economic, and environmental issues all at the same time, and consequently cannot be captured within the boundaries and approaches of individual scientific disciplines. Complex systems are still insufficiently understood, which indicates a lack of interdisciplinary (id) research taking place. Science organized in disciplinary structures acts like a number of blind persons investigating an elephant by touching different, non-overlapping parts. They come to entirely different conclusions about what the elephant really is. All are somehow right, all are somehow wrong, and nobody captures the entire context. And to take a step further – to not only understand complex systems, but also to improve, change, or transform them – we require a transdisciplinary research approach.



While transdisciplinarity (td) may be interpreted in different ways, in this book we use the definition and application of td as suggested by transdisciplinary net (td-net), Hurni and Wiesmann (2004), Lang et al. (2012), and Schneider and Buser (2018). Further thoughts about td can be found in the UN's *Global Sustainable Development Report* (Independent Group of Scientists 2019). According to Pohl and Hirsch Hadorn (2007), transdisciplinary research is appropriate under specific preconditions, e.g. if knowledge about a problem of societal relevance is uncertain, if the problem definition itself is still contested, and if stakes are high for those affected by the problems and their solutions. Td research is applied with a fourfold purpose: first, to capture the complexity of the problems; second, to consider the diversity of scientific and societal perspectives on the problems; third, to integrate abstract scientific knowledge and case-specific practical knowledge; and fourth, to assure that knowledge contributes to a practical solution that is oriented towards the common good.

Transdisciplinary research – in which different disciplines work with the participation of various stakeholders from practice – is appropriate for addressing:

- **ill-defined problems** i.e. problems that are difficult to define clearly, also referred to as ill-designed or ill-structured problems; and
- **wicked problems**, which are so complex that they are difficult or impossible to solve.



**Cartoon 4:** Wicked Problems – when reality changes faster than the model (Illustration: K. Herweg)

The proportion of research grants awarded to interdisciplinary and transdisciplinary projects has risen considerably in the last years (e.g. increased orientation of the European Union's Horizon programme towards the "third mission" of universities to promote service learning). However, id and td research grants are still underrepresented and disciplinary career paths still favoured. Consequently, there are only few examples of interdisciplinary and transdisciplinary learning opportunities for students. Generally, while students are able to take a range of courses, instruction remains discipline-specific and students lack in-programme, experiential, and transdisciplinary learning opportunities.

Much current research is relevant for specific aspects of SD. However, we need more **inter- and transdisciplinary research** to help us understand and shape complex social-ecological systems (SES).



Since SD – or any other sociopolitical paradigm, for that matter – is a normative concept, it cannot be defined globally or once and for all. Normative concepts involve judgment of, and negotiations between, a multitude of societal stakeholders. Such concepts must be permanently adjusted through processes of social or societal learning that involve actors from within and outside academia. Taking into account the normative character of SD, td research distinguishes between three types of knowledge:

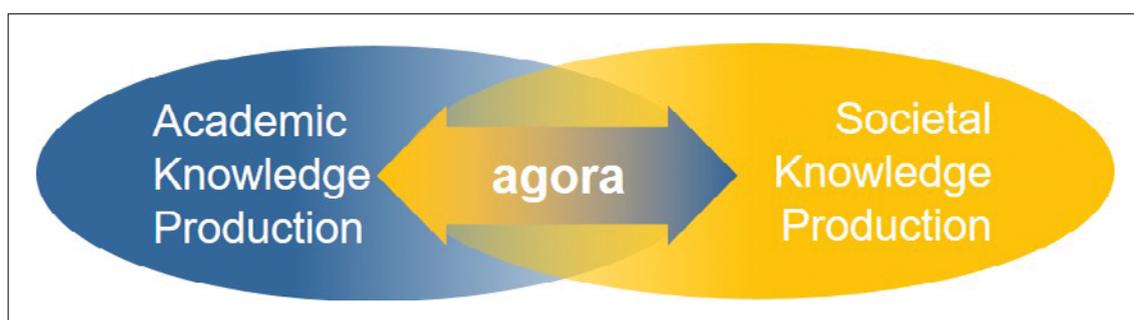
- **Systems knowledge:** Scientific contributions to understanding how environment, society, and economy function;
- **Target knowledge:** Scientific contributions to a vision of development; and
- **Transformation knowledge:** Scientific contributions to implementation of the vision.

While creating systems knowledge is the core business of many scientific disciplines, target and transformation knowledge are normative, value-laden categories. A participative strategy is thus required to capture as many different actor perspectives as possible, to make effective use of all available knowledge, and to develop solutions jointly. But what is the best way to exchange scientific and practitioners' knowledge and experience, in a way that is comprehensible to all?

In option one, the classical route, scientists produce and publish their knowledge first. As the material often contains technical jargon, however, it is not always understandable to others, even other scientists. Disseminating this knowledge might therefore involve "boundary organizations" – intermediaries between science and policy/practice – such as agricultural extension services, which transfer knowledge from agricultural research to farmers.

In option two, typical for a td procedure, one-way communication is replaced by knowledge co-production. Td research refers to this direct communication platform as "agora", the term used in ancient Greece to describe a public open space for assemblies and markets (see Figure 4). Communication between scientific disciplines on the one hand, and science and society on the other, is key to social or collective learning. In this option, borders between research, learning, and implementation become fuzzy. And "agora" denotes much more than the exchange of knowledge: it is also synonymous with the building of social and emotional skills as well as a constructive attitude, which are important preconditions for inter- and transdisciplinary work. From researchers it requires:

- a reflective and critical attitude toward one's own discipline, knowing its potentials but also its limitations, and the ability to question one's own standpoint;
- an open, tolerant, and respectful attitude towards other scientific disciplines, and the ability to manage conflicts of interest; and
- an open and trustworthy attitude towards non-scientific stakeholders.



**Figure 4:** Transdisciplinary research is knowledge co-production

Td research describes the direct communication platform on which this occurs as "agora", which refers to the marketplaces of ancient Greece and symbolizes the direct exchange of academic and other societal knowledge (Design: K. Herweg)

In conclusion, to achieve SD, we are in the challenging position of simultaneously seeking to understand and transform social-ecological systems which are constantly changing. Because they are characterized by complex interrelationships between society and the environment, understanding them requires a systems approach, which is inherently interdisciplinary, and transforming them is best tackled through a transdisciplinary research approach, which has been proven to make significant contributions to SD. The td approach

is synonymous with “knowledge co-production” or “social learning”. This requires methodological and social skills as well as a positive attitude towards SD. The next question is therefore: how can we design higher education for SD that prepares researchers for td research?

Transdisciplinary research = knowledge co-production = social learning



#### 1.4 Higher Education for Sustainable Development

“Education is not widely regarded as a problem, although the lack of it is. The conventional wisdom holds that all education is good, and the more of it one has, the better ... The truth is, that without significant precautions, education can equip people merely to be more effective vandals of the earth.” (Orr 2004, 5)

So how can we design curricula and courses that can help solve complex lifeworld problems? Such courses would enable students to learn how to analyse complex systems and work and communicate in transdisciplinary teams together with practitioners. We assume that many lecturers are unfamiliar with SD-related topics as well as with many didactic tools. Before embarking on the practical part of this book, we therefore provide some arguments to justify the focus we have chosen.

“The volume of education has increased and continues to increase, yet so do pollution, exhaustion of resources, and the dangers of ecological catastrophe. If still more education is to save us, it would have to be education of a different kind: an education that takes us into the depth of things” (Sterling 2011, 17, quoting Schumacher 1974)

This is what economist E.F. Schumacher wrote in 1974. Since then, various initiatives and activities have supported incorporating environmental education – and later, ESD – at various educational levels:

- In 2005, the United Nations launched the *Decade of Education for Sustainable Development (2005–2014)*, which aimed to mobilize the world’s educational resources to help create a more sustainable future.
- An important recommendation (WBGU 2011) demands nothing less than a “great transformation”, i.e. a substantial social change not only *within* the current system, but also *of* the system. This explicitly includes education that is geared towards transformation.
- Sustainable Development Goal (SDG) 4 “Quality Education” (2015) calls for *inclusive and equitable quality education and lifelong learning opportunities for all*.
- The *Framework for the Implementation of Education for Sustainable Development (ESD) beyond 2019* (UNESCO 2019) demands that ESD pay more attention to the deep structural causes of unsustainable development, such as the relationship between economic growth and sustainable development. ESD encourages learners to explore values that provide alternatives to consumer societies, such as sufficiency, fairness, and solidarity (circular economy, sharing economy, etc.). ESD promotes development as a balancing act, which implies adapting to changes while respecting the values of conservation, sufficiency, moderation, and solidarity.
- An important debate in SD literature criticizes that a major purpose of the current research and education system is to qualify people for jobs in a growth-oriented labour market (Gutiérrez 2016, Jickling 2017, Sterling 2017). Since the paradigm of constant growth is considered part of the problem of unsustainable development (Figure 2), so is market-oriented education. In short, it emphasizes competition, while ESD is all about cooperation.

A major purpose of the current educational system is to qualify people for jobs in a growth-oriented market economy. The paradigm of constant growth is considered part of the problem of unsustainable development – and consequently, so is current education.



- Is this something you have thought about or discussed with your colleagues and/or students?
- What is considered the main purpose of education in your institution?
- Does your institution educate people in a way that makes them capable of contributing to SD?
- What is your view on this statement, which summarizes a current ESD debate?

ESD is high on the agenda of current debates. And yet, the UN Global Sustainable Development Report (Independent Group of Scientists 2019) indicated that only very few of the 169 targets of the 17 SDGs are on track to being achieved, namely “under-five and neonatal mortality” of SDG 3 (“Good health and Well-being”) and “enrolment in primary education” of SDG 4 (“Quality Education”). All in all, the report rings a huge alarm bell and demands that efforts are significantly scaled up, as business as usual is not an option. Given what we know about unsustainable and sustainable development, and after all the campaigns, debates, papers, and activities that have promoted ESD in the past decades, this outcome is extremely unsatisfactory. In our opinion, the central question in the field of education is how to put ESD into action and move beyond critical self-reflection and controversial discourses.

Despite great efforts in certain aspects of SD and ESD, to date only few of the 17 SDGs’ 169 targets are actually on track to being achieved.



- In view of all the initiatives and related debates, papers, and pleas for SD and ESD, have you observed any substantial change in higher education in your university or institution?
- Does your institution encourage or support inter- or transdisciplinary research?

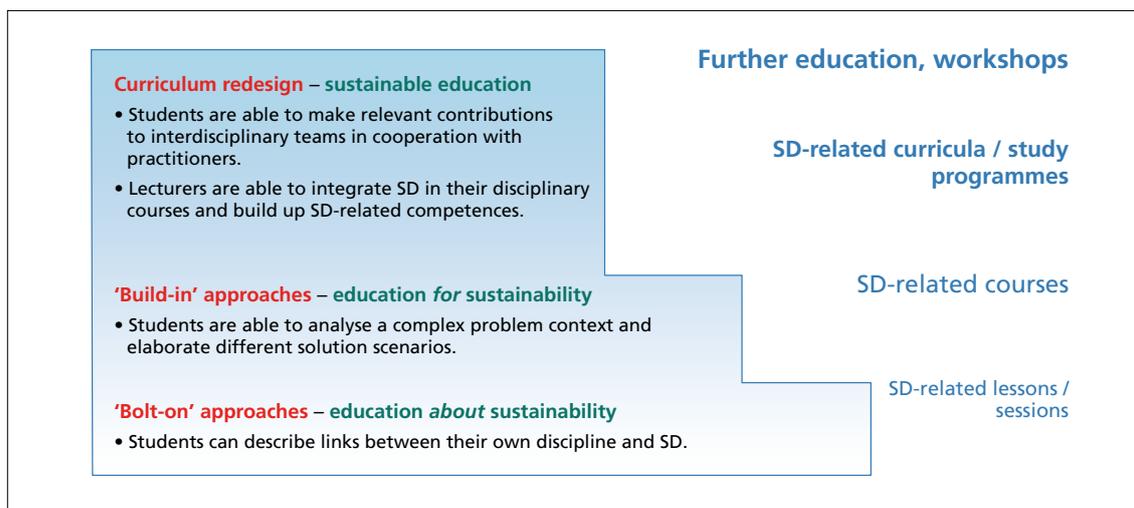


If your answer to both questions in the above Reflection box is yes, you will probably find support for ESD in your own institution, or you will be able to establish a network with colleagues who are also interested in SD and ESD or ready for transdisciplinary cooperation. However, in many universities this is not yet standard. Funded by taxpayers’ money (to varying degrees, depending on the country), and as consumers of energy and resources, etc., universities are part of society and should have a moral obligation to provide not only basic research but also socially relevant services (SDSN 2020). Yet, freedom of research and teaching appear to be paramount. Disciplinary academic structures do not block transdisciplinary research and education per se, but they are not supportive either.



**Cartoon 5:** Disciplinary Academic Structures: the world has problems; the university has faculties (Illustration: K. Herweg)

Despite this institutional barrier, there are a number of possibilities for integrating SD into curricula and courses (Figure 5; after Sterling and Thomas 2006). Newcomers to SD might consider, in a first step, applying a “Bolt-on” approach. This means that in individual lessons or sessions, they could include a discussion about what potential links their discipline has to SD, and, as a result, what contributions it might make. In a next step of engagement, a “Build-in” approach – creating an entire course around SD – is an opportunity for more in-depth discussions and exercises related to SD. To make full use of the potential of higher education for engaging in SD would require a “Curriculum redesign” or the creation of specific SD study programmes, supplemented by further education modules.



**Figure 5:** Steps of integrating sustainable development into tertiary education (K. Herweg, after Sterling and Thomas, 2006)

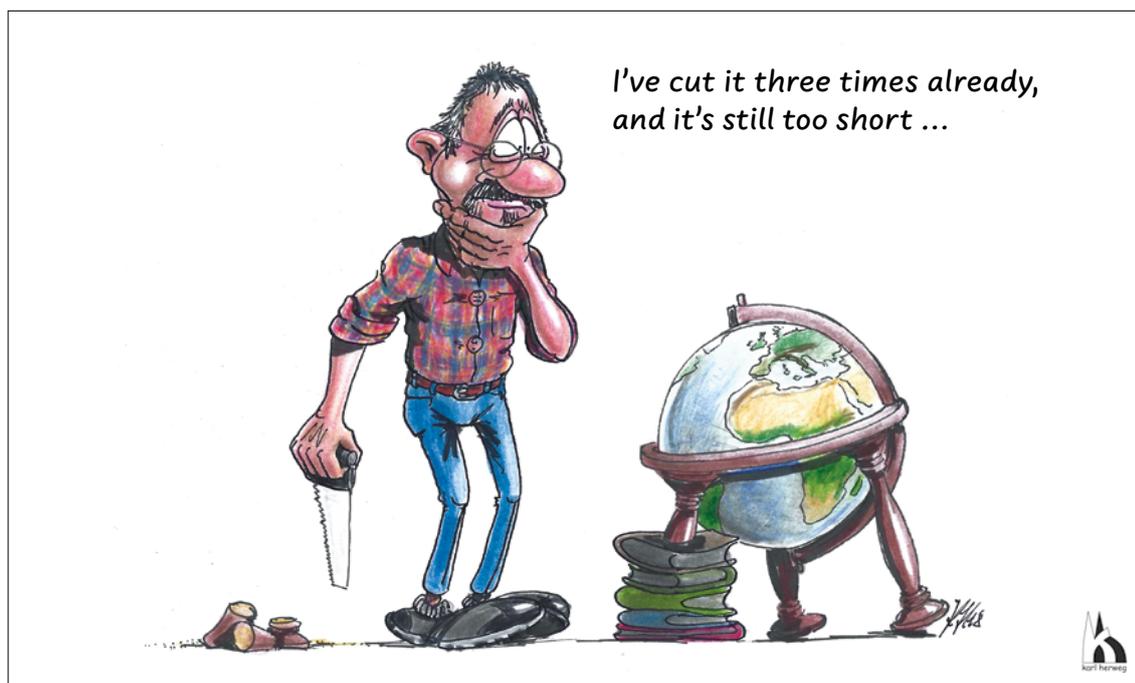
A “Curriculum redesign” requires ownership, engagement, and support of the institution. But even if the institution neither engages in ESD nor supports SD curricula, you can still transform your own courses through “Bolt-on” and “Build-in” approaches. Below, we further explain our focus on teaching and learning that supports students and lecturers in engaging with transdisciplinary research.

You have many options for integrating SD into your teaching, both at the institutional and at the coursework level.



## 1.5 Individual and Social Transdisciplinary Learning

ESD can prepare people to assume more responsibility and take a much more active role in transforming society towards SD: this is implied when considering SD as a continuous global societal process of searching, learning, and shaping. We began by thinking how to improve the role of science, i.e. research and education, in SD. In Chapter 1.3 we discussed td research – which can also be conceptualized as knowledge co-production and social learning – as highly suitable options for sustainability science. But social and individual learning processes go hand in hand. Transforming our individual ways of thinking and contributions to unsustainable development will thus be our starting point.



**Cartoon 6:** A “Great Transformation” ... is NOT about doing the same thing over and over and expecting different results (Illustration: K. Herweg)

In this context, the debate in ESD literature about “transformative learning” (TL) is highly relevant. TL is a process by which we transform our problematic and taken-for-granted mind-sets, paradigms, frames of reference, behaviours, and habits (Mezirow 2000). Mezirow described the basic premise of human thought, feeling, and action as “meaning perspectives” or “orientation-giving templates” for perceiving and interpreting new experiences. In a way, these meaning perspectives function like a pair of glasses that deny us an objective perception. Our values and sense of self are anchored in our frames of reference. They provide us with a sense of stability, coherence, community, and identity. Consequently, they are often emotionally charged and strongly defended. Viewpoints that call our frames of reference into question may be dismissed as distorting, deceptive, ill-intentioned, or crazy. Therefore, they are particularly difficult to change.

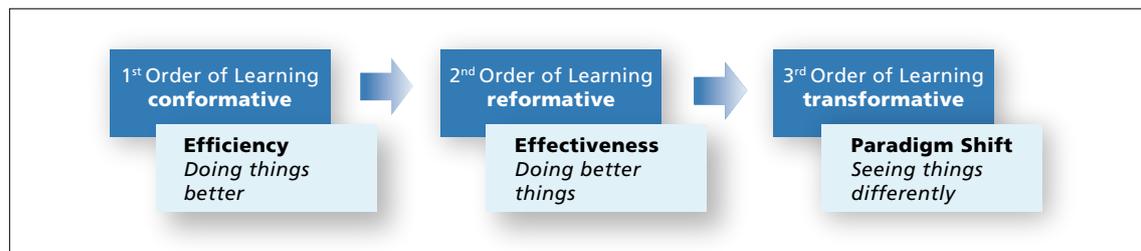
Mezirow’s focus on the individual was supplemented by Brookfield (2000), who compares transformative learning to a “shift in the tectonic plates of one’s assumptive clusters” (ibid. 139), but strengthens the importance of critical reflection as a collaborative project and a social process. A community of peers can serve as critical mirrors and provide emotional support on transformative learning journeys. O’Sullivan (2002) further stressed the societal level by stating that we are living in a period of earth’s history that itself is undergoing a transformation. All educational ventures must therefore be directed towards responsibility for the planet. Both individual and social learning for transformation demands leaving one’s personal comfort zone, which involves a certain level of disruption of our current ways of thinking and doing.

ESD has embraced TL as an approach to support learning that leads to transforming mindsets towards sustainability. A systematic literature review by Rodríguez Aboytes and Barth (2020) shows that from 1999 to 2007, the TL theory played a minor role in sustainability learning and ESD research. From 2008 to 2019,

however, articles combining TL and ESD increased steadily, indicating that TL has become an emerging field of inquiry. Even though the review also points out that TL is often used as a buzzword, it holds valuable insights for supporting the design and implementation of ESD.

Sterling (2011, building on Gregory Bateson) distinguishes between three orders of learning (Figure 6). The first is “conformative”, addressing the cognitive dimension (intellect): at this level, something new is learned without challenging the established (disciplinary) self-conception. The second order of learning is “reformative”, concerns the affective dimension (emotions), and is characterized by critically questioning and then adapting beliefs, values, and assumptions that make up self-conception. The third order of learning is “transformative”: it goes deeper and, through reflecting on and reconstructing self-understanding, addresses the existential dimension, the empowerment dimension, and the action dimension. It usually consists of several steps, such as:

- A transformation of someone’s frames of reference usually results from an irritation or “disorienting dilemma”. It can be triggered by life crises, or a series of previous transformations in meaning schemes, or – less dramatically – a dilemma created through a presentation or video, etc. The goal of the dilemma is to shatter taken-for-granted meaning perspectives and to create insecurity about them. In this phase, emotions play a big role.
- Such individual experiences need to be shared and reflected on among peers – the better argument counts, not the power of individuals. This is essential to reconstruct own perspectives, build new ones, and develop new skills, which enable a significant shift in awareness.
- Ideally, these new perspectives and skills are eventually integrated into daily life.



**Figure 6:** Conformative, reformative, and transformative learning (Adapted from Sterling 2011 by K. Herweg)

Which events, incidences, or experiences in our own lives have disrupted our habits of thinking and acting? Which of these had such a learning effect that it made us change our behaviour? Many of us may conclude that classroom lectures were not among them. Our own “transformative” experiences can help us identify relevant factors of TL, which collectively increase the probability of bringing students out of their “comfort zones”, and thus pave the way to transformation. Certainly emotions play a significant role around those transformative moments. And yet, TL is not automatic and success is not guaranteed, even if we consider all push and pull factors. As stated in Jickling (2017, 27) with reference to Gutiérrez (2016), “we do not create transformative moments, but can create spaces for them to arise.”

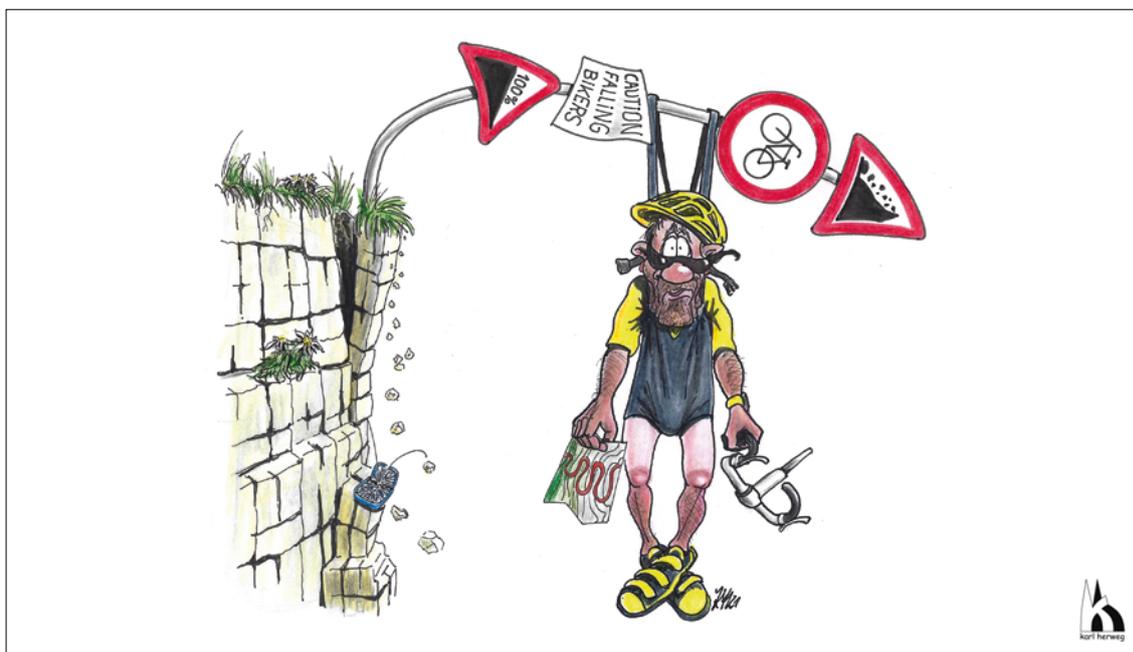
What transformative experiences have you encountered so far?

- Which events, incidences, or experiences in your life have disrupted your habits of thinking and acting?
- Which of these have had the biggest learning effects, making you change your behaviour fundamentally?
- As a student attending a course, can you recall a “transformative moment” that made you change your mindset or even behaviour?



A **problem- and solution-oriented learning approach** offers multiple opportunities for transformative moments to arise. Experiential learning under real-life conditions enables deep-level learning to occur.





**Cartoon 7: Transformative Moments** (Illustration: K. Herweg)

Another important educational debate (Singer-Brodowski 2016) warns that ESD should not be misused as a politically hued education that results in overwhelming and manipulating the learner. Competence orientation in ESD should enable students to decide and act autonomously after critical reflection of values and visions that are often taken for granted. It therefore has an emancipatory role to play and is not about implementing other people’s visions for SD. We therefore believe that transdisciplinary research (Chapter 1.3) and learning inherently largely prevents learners from being overwhelmed and misused for political agendas. First, SD is an extensively debated, well-justified global agenda; the SDGs were negotiated and are widely accepted. Second, research and learning explicitly emphasizes knowledge co-production and social learning, and it follows that working in a diverse group may involve controversial discussions from different actor perspectives, reflections on one’s own position, negotiations regarding research questions, and the ability to compromise.

How, then, can social learning processes be facilitated? From our description of td research (Chapter 1.3), we can derive several principles with which to start designing transdisciplinary education (learning environments) that, at the same time, can enable transformative moments to arise. We invite you to add further points to this list:

- Work on a real-world issue, with complex, current problem settings;
- Be solution-oriented in your approach to this issue;
- Bring together students from various disciplines;
- Allow students to interact with actors from practice (experiential learning) outside the classroom;
- .....
- .....
- .....

Considering these principles will help you design learning-through-action scenarios which are inherently learner-centred and which enable transformative moments of learning. Such scenarios imply that situations are constantly evolving, driven in part by the interaction between students and other actors. This dynamic encourages students to automatically take a more active role and assume more responsibility for the success of the course. A student-centred approach also makes it more likely that students will build critical awareness leading to stronger motivation and emotional engagement in SD.

**Transdisciplinary learning** prepares students to cooperate and communicate with scientific disciplines other than their own, as well as with other societal actors, to elaborate solutions for **ill-defined** and **wicked problems**.



In “wicked problem” settings, a constructivist approach to learning seems appropriate to develop the required knowledge, skills, and attitudes/values. Constructivism considers the learner part of one’s environment and typically challenges learners with complex, open-ended questions (Herweg et al. 2012). We recommend, for example, “Case-Study-Based Learning” (CSBL, *ibid.*), a blend of “Problem-Based Learning” (PBL, e.g. Funke 2003, Müller 2008, Reusser 2005, Yamin and Masek 2010) and transdisciplinary aspects such as encounters with societal actors. CSBL focuses on a real-world situation, with real actors, real problems, and real solutions – and is thus more likely to create spaces and opportunities for transformative moments to arise than by using a theoretical situation.

**Case-Study-Based Learning** (CSBL) is a key component of transdisciplinary learning, because a real-world setting offers a much broader array of opportunities than classroom teaching, to develop SD-relevant knowledge, skills, and critical awareness.



### Sharing experience: How we have applied CSBL

There are many ways to integrate CSBL into your teaching and bring students and practitioners together: just keep an eye out for opportunities appropriate to your specific subjects. In our courses (described in Chapter 5), we handle this as follows:



The city of Bern is surrounded by a rural agricultural landscape, accessible from the University within 30 minutes by public transport. Fieldwork is thus easily possible within our four-hour afternoon blocks. For many years, we have taken students to visit farmers there. Embedded in a strong sociocultural societal context, the farmers manage natural resources such as soils, water, plants, and animals to earn their living, sustain their livelihoods, and produce food and fodder. By talking to the farmers and reflecting on their own consumption habits, the students learn how consumer behaviour and wholesalers influence the quantity and quality of agricultural products. By conducting further research, the students discover how policymakers and rural “society” frame the working conditions and activities of the farmers.

In this real-world context, the students experience a complex setting – in this case, a food system – that is challenging to understand. How can the farmers practice sustainable agriculture without slipping into practices that may be cheaper and easier but unsustainable? Such complexity appears as a wicked problem. Small-scale farming is often uneconomic, but what effects would giving it up have on natural resource use and rural societies and traditions? Available information is incomplete, actors have hidden agendas, and there are no blueprint solutions to hand. Students have to develop new skills for problem diagnosis, elaborating strategies and solutions, proper communication, etc. Such case studies provide a lot of transformative moments and excellent opportunities for transformative learning.

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## 2 Transdisciplinary Learning for Sustainable Development: A Quick Guide

### Guiding Questions

1. What are potential **links** between your discipline and **SD**?
2. What **fields of work** will the graduates enter?
3. What **typical situations** will students have to **master** within these fields of work?
4. What **competences** do students need to master these situations?  
At the end of the programme / course ...
  - ... What do they know (**academic knowledge**)?
  - ... What can they do (**professional skills**)?
  - ... What are their attitudes and values (**critical awareness**)? What **factors** promote **critical awareness** in SD?
5. What are the **basic organizational conditions** of the course, in terms of both teaching and target group?
6. **Constructive alignment**
  - ... What are the intended **learning outcomes**?
  - ... What **learning activities** will help students to achieve these learning outcomes?  
What learning environments and teaching–learning arrangements support creating spaces for transformative moments?
  - ... How will you assess whether students have achieved the learning outcomes? What **assessment** formats help to determine incremental achievement of the intended competences?
7. How and when will you **evaluate** the **effectiveness** of the teaching–learning arrangements and teaching strategies? What transformative moments could appear during the course?

### 3 Developing Effective ESD

High-quality educational settings are underpinned by empirically supported principles. This chapter presents general principles and processes for developing effective education and training for SD. We look at the overall system of three didactic levels: macro (the overarching study programme), meso (the modules), and micro (the courses). The processes are the path from macro via meso to micro level. While our introduction can apply to all three system levels, we begin by examining the macro-didactic perspective.

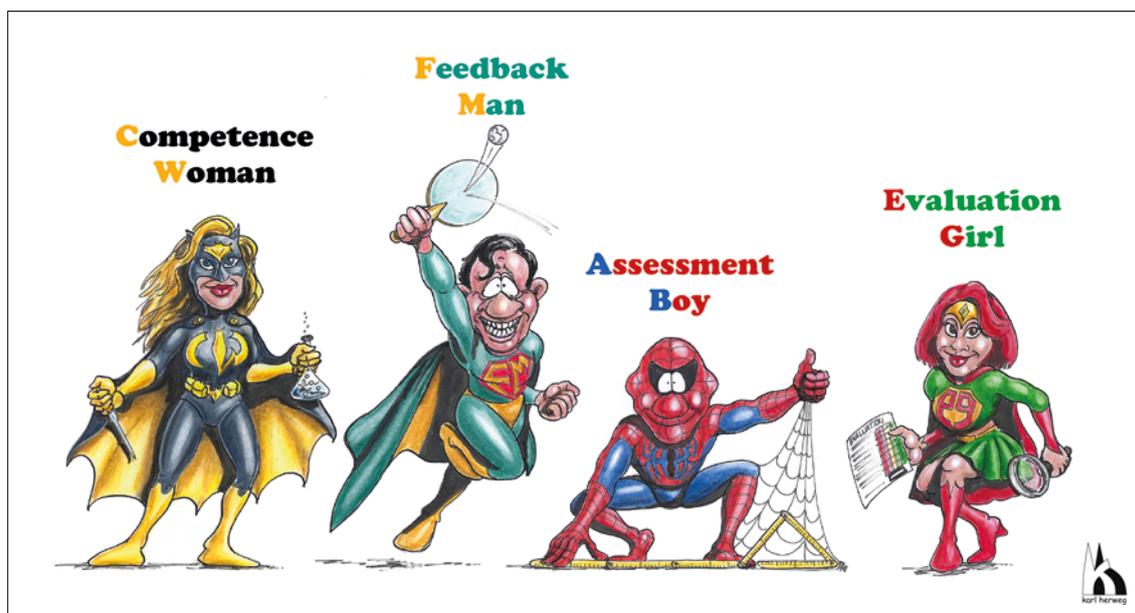
Chapter 1 outlined our focus on education for sustainable development (ESD) and on aspects of transdisciplinary learning. To recap, this involves creating a learning environment that considers complex real-world contexts, involving societal actors and knowledge co-production, and enabling transformative moments and emotional engagement.

#### 3.1 Introduction and Basics

Many teaching traditions continue over generations and are hardly questioned, even if they show little effect. This still seems to be the case, despite the availability of guidance by empirical pedagogical and psychological research on how to design effective education and training programmes. This research provides a reliable basis to develop high-quality educational programmes, which in turn improves efficiency and cost-effectiveness. But how can this evidence reach the huge majority of lecturers unfamiliar with pedagogical and psychological research and its terminology? This is one of the aims of this book: to illustrate the usefulness of such research by applying it to various courses. This means also adapting research findings to suit the reality of lecturing.

The following sections provide principles for designing teaching–learning arrangements. Derived from synthesizing publications that are based on robust empirical research, the principles

- make a substantial contribution to students’ overarching learning success;
- are underpinned by empirical research rather than teaching traditions based on anecdotes (“folksology”); and
- can be used in different disciplines.



Cartoon 8: The Superheroes of Higher Education (Illustration: K. Herweg)

### 3.1.1 Competences for change agents

How many of your students, after completing their academic degree, work in research and teaching? How many of them take on other positions of responsibility in administration, private industry, civil society, politics, etc.?



All university graduates can assume positions of responsibility in research, teaching, administration, private industry, civil society, or politics. This means that they can all become change agents who contribute substantially to more sustainable development. ESD is a challenge, because merely “transferring” information is not enough for transdisciplinary learning – complete with transformative moments – to occur. There is a world of difference between information and knowledge, and knowledge and action competence. Change agents for sustainable development must have the competence to act professionally. But what is “competence”?

The literature contains a multitude of definitions of competence, including some that relate to the field of education and training. The models and definitions have evolved over decades, with some claiming to be universal and others limited to a specific field. The competence model presented in Chapter 3.3.2 was deliberately selected as being suitable for adaptation to the needs of ESD. Overall, however, the diverse definitions agree on some essential points. One of these is the relationship between knowledge and competence.

#### Knowledge alone is not competence

Knowledge alone does not equal competence, but knowledge is a central resource in almost all competence models. For many decades there has been agreement in the Western educational system that skills and critical awareness (e.g. attitudes and values) are essential, in addition to knowledge, for a holistic education as a basis for solving real-world problems. Knowledge, skills, and critical awareness are regarded as the classic triad of didactics (see Figure 11) and thus as the precursors to almost all competence models relevant to education.

#### Knowledge and action

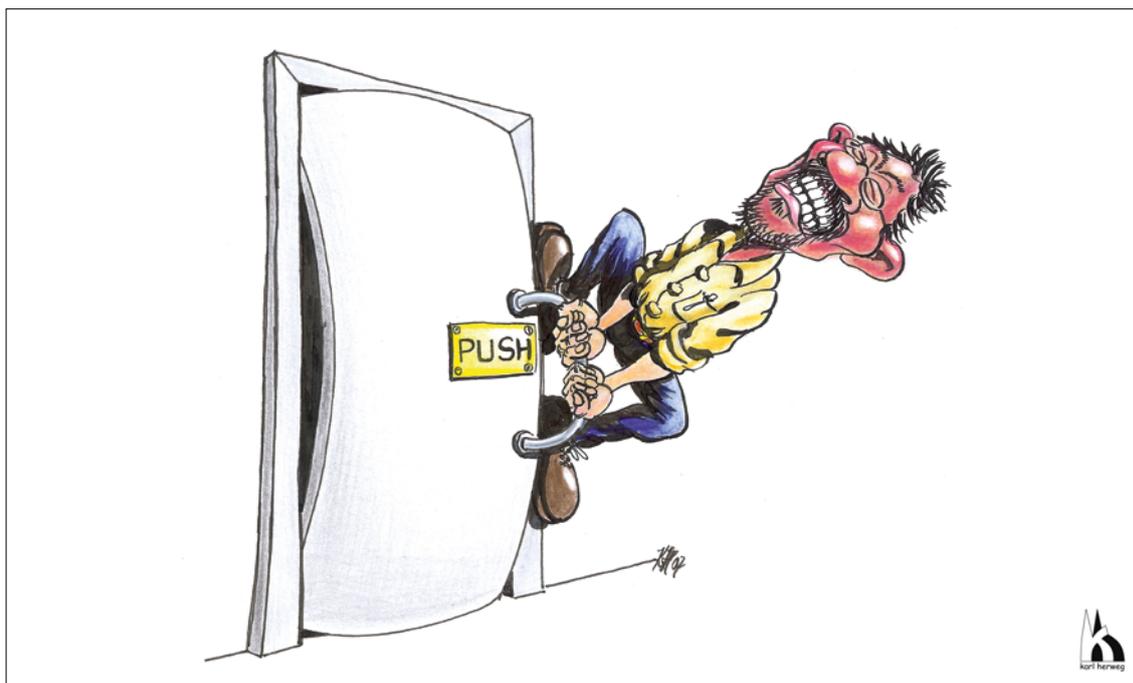
Is knowledge, then, no longer important? Of course it is! Knowledge is central for students. But in the context of SD, knowledge must be linked with action. Transformation will not succeed if students can only explain – but not apply – models, theories, and concepts. The goal must be to understand and to apply them, e.g. in the form of statements, analyses, or development actions.

#### Inert knowledge

Whom would you rather entrust with the surgery of your broken leg, a fresh medical school graduate or an older surgeon with thirty years of operating experience? Most people would probably choose the older person because of their experience – although not necessarily only because of their years of practice. It is also their expertise in fusing their academic knowledge, professional skills, and critical awareness that we appreciate, which enables them to deal with different situations, flexibly and confidently. Intuitively, we know that pure theoretical knowledge alone is not enough. And yet, countless training programmes around the world are still set on the idea of knowledge transfer in a “spray and pray” manner. Meaning that a vast amount of information is “sprayed” over the audience in the hope of it somehow inspiring, and more importantly, enabling students to disseminate it and thus to change the world.

To understand the relevance of competence orientation for education, it is important to understand a central concept of learning research: inert knowledge. As early as 1929, the concept was named by British philosopher and mathematician Alfred N. Whitehead:

*“Theoretical ideas should always find important applications within the pupil’s curriculum. This is not an easy doctrine to apply, but a very hard one. It contains within itself the problem of keeping knowledge alive, of preventing it from becoming inert, which is the central problem of all education”* (Whitehead 1929, 5).



**Cartoon 9:** Inert Knowledge – published knowledge alone doesn't trigger behaviour change (Illustration: K. Herweg)

As a result, knowledge that once was acquired but cannot be retrieved to solve problems is called inert. Often, learners have a lot of theoretical knowledge that can be retrieved through traditional forms of assessment. In later practice, however, we observe that this knowledge can neither be used to guide action nor perception. Many reasons relate to this ineffectiveness of academic knowledge, which cannot be discussed in detail in this book.

The experienced surgeon, too, has acquired extensive specialized knowledge. By performing numerous surgeries, they have repeatedly tied this knowledge to typical situations, gradually developing the ability to recognize patterns. This helps them to recall the corresponding knowledge in the next comparable situation and is the essential difference to the young, newly qualified doctor: the young doctor has not acquired their knowledge in an application context, making it harder to reactivate it later in problem-solving situations. Cognitive research therefore considers knowledge generally as context dependent (more on this in 3.1.3 on Situational learning).

Whitehead was a respected mathematician and philosopher. When he spoke about the application of knowledge, he did not primarily mean vocational skills. Rather, the application of knowledge was important to him in an academic context. Whitehead's ideas can thus be understood as a response to critics who disparage "competence orientation" (see below) as "non-academic", "unscientific", or "undemanding". Science, too, is a field of activity that requires competences.

### Competence orientation

The basic approach to developing effective educational concepts can thus be described as competence orientation. This idea originated in the 1990s as a shift in perspective from teaching to learning (Barr and Tagg 1995): teachers should not think only in terms of what information they want to present; instead, they should consider what the learners must be able to do at the end. This situation management by the learners provides the starting point for designing effective education and training programmes. Competence orientation aims to avoid building up inert knowledge (Renkl 1996).

**Information** is not yet **knowledge**, knowledge alone is not yet **competence**. But knowledge is a central resource in almost all competence models. All elements of the classic triad – **knowledge, skills and critical awareness** (i.e. values, attitude) – are essential for a holistic education that prepares people to solve complex, real-world problems.



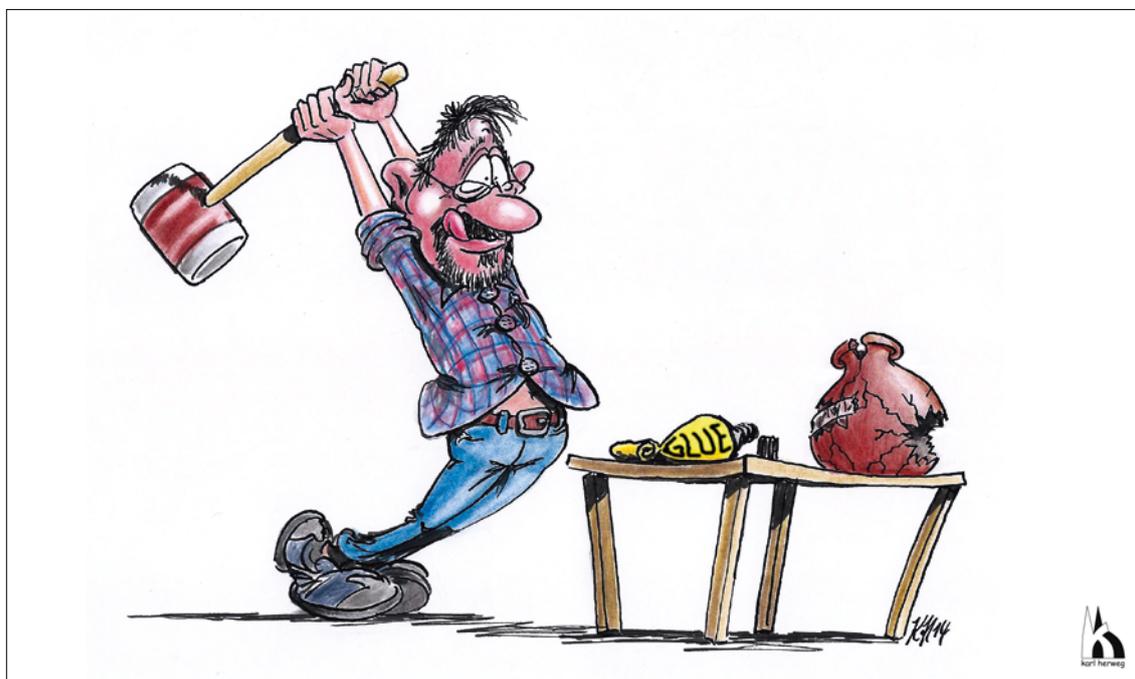
### 3.1.2 Metacognitive strategies – thinking about thinking

Metacognition refers to the reflection on one's own processes of thinking and information processing. Research shows that learners of all levels have more academic success when they are able to better assess their abilities, have a broader array of working strategies and learning techniques, and can use these in a situation-specific and targeted way. Applying metacognitive strategies is thus an effective way to support successful learning processes.

#### Maslow's hammer and the law of the instrument

*"If all you have is a hammer, everything looks like a nail."* While the original author of this phrase is not known for certain, its meaning has been used by celebrated thinkers such as American philosopher Abraham Kaplan. *"I call it the law of the instrument and it can be formulated as follows: give a little boy a hammer and he will find that everything he encounters must be hammered"* (Kaplan 1964, 28). Around the same time, psychologist Abraham Maslow published his version: *"I suppose it's tempting to treat everything like a nail when the only tool you have is a hammer"* (Maslow 1966, 15), which is probably why the principle subsequently became known as Maslow's hammer. But how is this connected to the development of innovative educational concepts? On the one hand, it means that professionals must have a wide range of methods and skills at their disposal to enable a broadening of perspectives – being restricted to only one tool would limit the perception of the problem situation. But there is another consequence.

People often revert to former behavioural patterns, especially when under pressure. Professionals, however, are expected to be aware of this, to have a variety of methods at their disposal, and to be able to use the appropriate methodology (i.e. tool) for each problem. Their toolbox must therefore not only be well stocked and contain more than Maslow's hammer; they should "play the entire keyboard" and take the right tool out of the box in every situation. Needless to say, they must also be able to handle these tools, i.e. to have the appropriate skills.



**Cartoon 10:** Maslow's Hammer (Law of the Instrument) – it is tempting to treat everything like a nail when the only tool you have is a hammer (Illustration: K. Herweg)

#### Thinking about one's thinking

High-quality education and training concepts today are not only expected to minimize the build-up of inert knowledge and to use a broad repertoire of teaching methods. Learners should also be enabled to observe, analyse, and optimize their own actions from "the outside", so to speak, proceeding in this way to "a higher level of learning". Taking this into account is a great challenge for teachers, because applying metacognitive strategies requires a certain amount of knowledge about human learning, particularly academic

learning. Metacognition means “thinking about one’s thinking”. To develop metacognitive strategies for teaching, it helps to use contemporary competence models and to implement them consistently through innovative learning scenarios. This is already happening today. Medical emergency teams, for example, have long conducted joint analyses after an emergency situation and compared their response to evidence-based best practices. In structured debriefings, team members reflect on their own actions in relation to the scientifically-founded, ideal processes. Every problem-solving situation is thus used as a learning situation.



**Cartoon 11:** Metacognition: thinking about one’s thinking (Illustration: K. Herweg)

### Metacognitive strategies and ESD

ESD ultimately aims to enable learners to act consciously and purposefully. It is essential that this action is guided by evidence rather than by ideology and opinion. A key concern of ESD is that learners develop a self-reflective personality, which makes metacognition more relevant than ever. For example, many development aid projects in the 1960s, although well-intentioned at the time, today appear as though they had succumbed to the law of the instrument. A lack of overview, an inability to consider complex contexts, monocausal explanations, and the tendency to lapse into unreflective activism are all closely linked to poor metacognition. The focus on short-term outputs instead of medium-term outcomes and long-term impacts is a pernicious tendency of human action that must be addressed in ESD (Kahneman 2011).

Having a metacognitive strategy in place leads to more successful learning. Research shows that learning success is significantly greater where learners set clear goals, divide the learning material into portions, subject their learning process to a constant target–performance comparison, and preside over a repertoire of learning strategies enabling them to switch to a more suitable option, if necessary. In addition, conscious learning and deliberate practice have more beneficial effects. If SD is a permanent process of searching, learning, and shaping, then applying metacognitive strategies is key to ESD. Suitable teaching–learning arrangements to help students acquire such strategies are presented in Chapters 3.4.3 and 4.

Metacognition means **“thinking about thinking”**. ESD is no longer just about having “informed citizens”; it is about self-reflective, innovative, and forward-looking actors who participate actively and take on responsibility.



### Ill-defined problems

In the early days of research on artificial intelligence, it was recognized that if information technology was to be useful to humans, it had to be able to deal with a completely different kind of problem than the usual mathematical ones. This is why we speak of ill-structured problems (Simon 1973), “ill-defined problems” (Reitman 1965), or “wicked problems” (Chapter 1.3). First, we have to recognize problems as ill-structured or ill-defined where the corresponding situations are characterized by unclear goals and incomplete information. Problem settings in sustainability contexts, in particular, are complex and not well structured. Future change agents already need a certain expertise to be able to recognize such problems, because often the chaos they see makes no sense at first glance and a situation analysis is impossible. Later, as experts in their respective fields, it is possible to suddenly recognize recurring patterns, provided one has already “seen” a number of comparable situations. This is sometimes the reason why experts despair when learners do not recognize something that appears obvious to the experts. It is a strong argument in favour of situational learning, in which learners are also trained to deal with complex problems. How this can be implemented is described by the concept of productive failure (Chapter 4.5).

### Holistic learning

We may conclude that to be considered holistic, education and training programmes for SD must promote at least three essential areas: “academic knowledge, professional skills, and critical awareness” (see Figure 11). Only holistic learning is truly transformative learning that can make a significant contribution to personal development. Critical awareness, for example, is difficult to develop without emotional involvement. This idea is not new – it was formulated long ago by thinkers in reform pedagogy, such as Pestalozzi or Rousseau. Of course, “situational learning” is the best way to enable these aspects to develop. Learning in situ means that the participants build up their competences in situations that are as realistic as possible, e.g. in projects, field studies, internships, or “service learning” (i.e. learning through activities for the benefit of society at large).

Only **holistic learning is transformative learning**. Holistic learning addresses the classical triad of course objectives: **academic knowledge, professional skills, and critical awareness**.



#### 3.1.3 Situational learning

It is undisputed that ESD must ultimately lead to learners developing competences for action. This is possible if the education and training concept is based on a competence model in which planning, implementation, and evaluation are aligned. An appropriate approach in this respect is “situational learning”, because situations are what students will have to master in later life.

#### Context-dependent memory

Unreflective cramming leads to inert knowledge and should be avoided. If relevant knowledge is learned in a prototypical situation, this situation functions as an anchor for the associated knowledge, making it easier to remember later. The more similar the later problem-solving situation is to the previous learning situation, the easier it is to reactivate the associated knowledge. Therefore, situations lie at the start of a learning process in effective teaching–learning arrangements. They trigger enquiry and knowledge acquisition and have long formed the core of many successful education and training programmes around the globe. Decades ago, universities such as Harvard or McMaster implemented “Problem-Based Learning”, a model to put these basic ideas into action. Other, comparable approaches will be discussed later.

**Situations** – preferably emotionally charged ones – serve as **memory anchors for associated knowledge**. In formal training settings, situations that have been reduced in complexity serve as starting points to trigger learning processes.



### Situations as Starting Points (SSPs)

SSPs are one of three pillars in the binding national qualification framework for medical training at Swiss universities. For conceptualizing study programmes, they are supplemented by a role model as well as by “Entrustable Professional Activities” (EPAs). These are protocols of action that medical graduates are trained in and must be able to master by the time they graduate.



SSPs of learning processes can vary in their complexity. For example, quoting correctly is not at the same target level as the ability to judge historical sources. The SSP approach is not just professional training; it is more a matter of considering potential fields of work including typical situations to master. This includes situations in scientific activities, e.g. presenting research data, using models for structural analysis, describing chemical reactions, deriving theorems, developing questions, deploying research designs, writing technical texts, etc. Engineers, lawyers, city planners, managers, policymakers, economists, industrialists, health workers – the list of professions in which more or less complex situations have to be mastered is endless. Situations of sustainable development must therefore be at the centre of the conception of corresponding ESD programmes.

### Including situations in your teaching strategies:

- Actively involve participants’ prior knowledge and experience, e.g. by asking them questions either on-line in advance or live in the lecture hall;
- Present the context, initial situation, problem or examples in advance;
- Show applications or products based on the research;
- Present some examples from your own research or research at your institution;
- Link theory with practice by using relatable examples, or ask the students to provide examples from their everyday life, so that learning contents refer to contexts and actions that are relevant to the participants;
- Organize situational learning, i.e. cooperative learning in the field, in real-world projects.

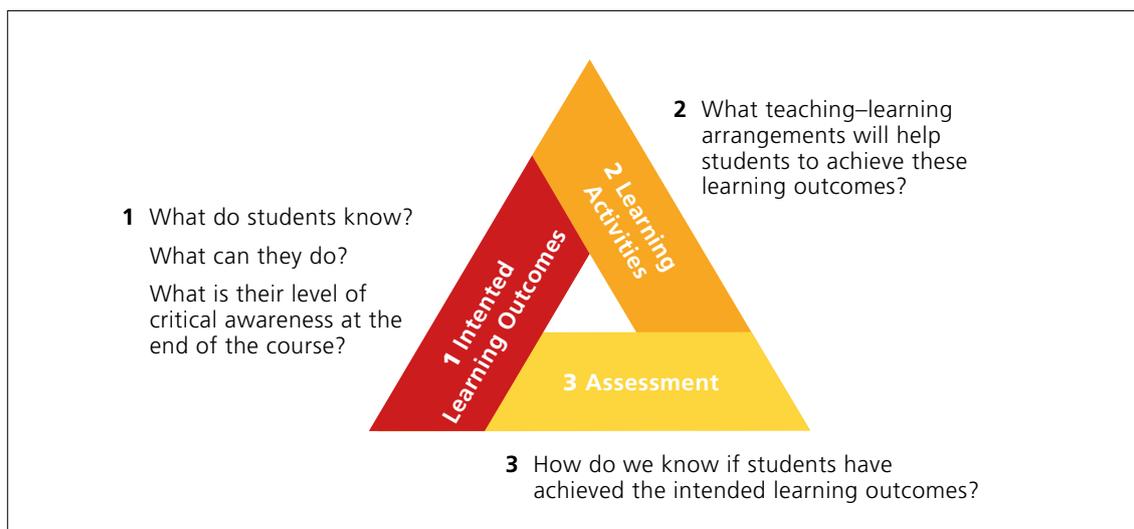
**Situational learning** is an approach that puts situations at the start of a learning process. Situations trigger enquiry and knowledge acquisition and have long formed the core of many successful education and training programmes. Although “situational learning” is a relatively new term, the roots of this approach are quite old.



### 3.1.4 Constructive alignment

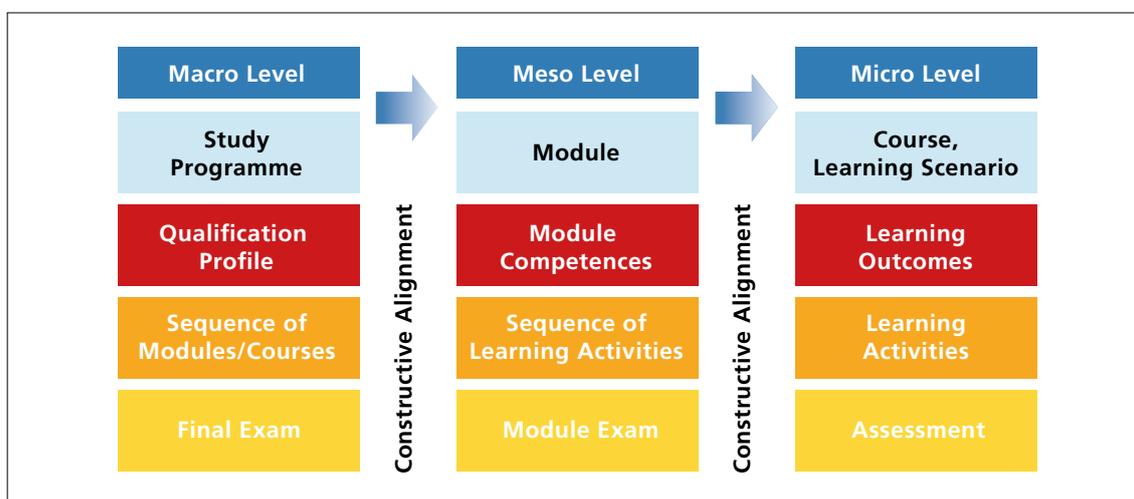
In the mid-1990s, John Biggs presented “constructive alignment”, a guiding idea for the design of study programmes. Constructive alignment stipulates that three core elements must be aligned (Figure 7). At course level, for example, these are: “learning outcomes” (specifying the competences to be built), “learning activities” (teaching–learning arrangements), and “assessment” (of competences) (Biggs 1996). The term *constructive* implies that the learners themselves make content meaningful through relevant learning activities. Relevant activities are primarily those linked to the goals of the course, i.e. the learning outcomes, which describe what learners are expected to know (knowledge) and be able to do (skills), as well as the status of their attitudes and values (critical awareness). This makes teaching a catalyst for learning.

Thus, teaching can also be understood as empowerment. The appropriate teaching–learning arrangements support learners in achieving – and demonstrating – the competences that have been formulated as learning outcomes. A teaching–learning arrangement includes time for individual study and must be coherent, in that it enables the student to achieve and demonstrate the intended outcomes through the assessment. This constitutes *alignment*.



**Figure 7:** Constructive alignment at the level of courses and learning scenarios  
 This can also be referred to as “didactic coherence”, and characterizes high-quality education and training programmes (Design: K Herweg)

To ensure constructive alignment within and across the levels of modularized study programmes (see Figure 8 and explanation of levels in Chapters 3.2–3.4), it is worthwhile further differentiating Biggs’s thoughts. At *study programme* level, coherence should be ensured between the final competences specified in the qualification profile, the sequence of modules and courses across the study programme, and the final exam. At *module* level, module competences, the sequence of all learning activities, and the module exam should be coherent. At *course* level, learning outcomes, learning activities (teaching–learning arrangements), and assessment should be compatible. Following Biggs and taking into account the three levels (micro, meso, macro), this central principle can also be called “didactic coherence”.



**Figure 8:** Elements of constructive alignment at the macro, meso, and micro levels  
 Of course, terminology may differ, depending on institution and context (Design: K. Herweg)

Although the basic idea of constructive alignment may be plausible to and well-known among educational experts, its implementation in educational programmes and courses by other lecturers is unfortunately still rare. Too often it is assumed that merely showing or explaining cases will *somehow* enable the audience to manage them later, or that a mathematical proof written on the blackboard at breath-taking speed will lead to *eureka* moments on the part of the audience. Tongue-in-cheek, German educator Diethelm Wahl speaks of “Whitsun-Miracle Didactics”, because in such cases teachers assume that their students, animated by “tongues of fire” spewing a flood of scientific facts and words, will be equipped to change the world professionally following their studies (Wahl 2006).



**Cartoon 12:** Spray & Pray, or “Whitsun-Miracle Didactics”: the assumption that students, spurred on by hearing floods of scientific facts and words, will change the world professionally after they leave the classroom (Illustration: K. Herweg)

The following central questions serve as a proof of coherence when designing courses and study programmes:

- Is the form of assessment suitable to verify that the learning outcomes were achieved?
- Do the learning activities truly prepare students for achieving the learning outcomes?
- Do the learning activities (teaching–learning arrangements and learning processes) of all courses in a study programme complement each other to foster overall competence development (qualification profile)?

If the answers to all three questions are a clear “yes”, then the study programme, module, and courses are likely to be constructively aligned.

**Constructive Alignment** is a guiding principle of high-quality educational programmes. It requires coherence between the three core elements – **learning outcomes** (competences), **learning activities** (teaching–learning arrangements), and **assessment** (of competences).



### 3.2 Macro Level: the Programme Architecture

In the following Chapters (3.2–3.4), we assign the **guiding questions** (see Quick Guide, Chapter 2) to different levels of the study programme architecture: macro, meso, and micro level. If however you are responsible only for a module (meso level) or a course (micro level), **we recommend that you follow all the guiding questions in the order they appear in the Quick Guide.**



Study Programme (Qualification Profile)							
Module 1 (Module Competences)		Module 2 (Module Competences)			Module 3 (Module Competences)		
Supervised Self-Study		Supervised Self-Study			Supervised Self-Study		
Course (Learning Outcomes)	C (L.O.)	C (L.O.)	C (L.O.)	C (L.O.)	C (L.O.)	C (L.O.)	C (L.O.)

Figure 9: Three levels of abstraction in an ideal-typical study programme architecture (Design: K. Herweg)

### Study programme and qualification profile

We distinguish between three levels: study programme, modules (including supervised self-study), and courses. These are depicted in Figure 9, in an ideal-typical structure that simplifies programme development and is in line with the logic of competence orientation. Following this hierarchical structure makes it easy to understand the programme architecture and to allocate responsibilities. Please note though that depending on institution and context, terminology may differ. Each level contains the elements of the level(s) below. At the top level, competences are described in relatively general terms to define the qualification profile.

#### Social Anthropology 1

#### Qualification profile of a Social Anthropology degree programme (e.g. Master's level)



Students learn the basic concepts of social anthropological theories and methodology. They are familiar with key texts of the subject and can classify them according to the respective fields of knowledge. They acquire knowledge on the history, the different schools of thought, and the sub-areas of the subject, and can present these. They can develop research questions, establish reflexive research relationships, apply participant observation and different survey methods (field research techniques), and carry out a guided research process. Students are able to deal with translocal and mobile field-research situations. They understand the basics of at least one non-European language, can write scientifically, understand and analyse texts, present scientific content, cooperate in teams, and manage their knowledge. They can write independent short papers, combining their acquired knowledge on social anthropological theories, comparative systematics, and methodology.

A qualification profile refers to the macro level: i.e. it is very general and cannot be implemented directly. This is why more detailed descriptions are needed at meso level (module competences). Finally, module competences are broken down into learning outcomes (at the micro level). These steps will be explained in detail in the following subchapters. First, though, some thoughts on the connection between various scientific disciplines and the field of SD.

A qualification profile (macro level) must be broken down into specific module competences (meso level). In turn, module competences are broken down into learning outcomes (micro level).



### 3.2.1 Potential links between various scientific disciplines and SD

You can design your study programmes, modules, and courses using a series of interrelated guiding questions (see Quick Guide, Chapter 2). If you wish to emphasize SD in your teaching, the first Quick-Guide question involves identifying what connects your discipline with SD. This applies regardless of level: macro, meso, or micro. For several scientific disciplines, the link to SD is quite obvious and direct; for others, it is more hidden or indirect. If the latter applies, it might take some time to identify potential connections at different levels. It can help if you think in terms of the following four interfaces:

- **Research topics:** probably the easiest links are *thematic*: e.g. research on core topics and issues of SD such as natural resource degradation, globalization, migration, etc.
- **Research methodology:** measuring or determining changes in *key variables* is essential to assess whether development is sustainable or not. Thus, any scientific method that helps to collect quantitative and qualitative data of key variables is a contribution to monitoring and assessing changes and impacts of activities, technologies, etc. that relate to sustainability.
- **Theory:** contributions to *critical debates* about SD in general, or about various issues of SD, for instance, are useful contributions on a conceptual level.
- **Application:** finally, applying research results has *direct impacts* on SD, such as developing sustainable technologies, formulating laws regulating environmental care, ESD, etc.

What links does your discipline have with SD? To help you identify these, try exploring one or more of the following pathways: **research topics, research methodology, theory, and application.**



The following grid pattern analysis (Figure 10) combines the four interfaces mentioned above with the three dimensions of SD (environment, society, economy). Such an analysis is particularly important when developing or adapting study programmes that go further than a “bolt-on” approach (Chapter 1.4) and that aim to integrate sustainability topics in a “build-in” approach or even a substantial “curriculum redesign” towards ESD.

For systematic and significant contributions to SD, we propose that lecturers identify several potential links between their scientific discipline and SD. Please try to answer the key questions below for your own discipline. Depending on the structure of the study programme or of the responsible institution, this analysis can be carried out at different levels (macro, meso, and micro). It is ideally carried out at all three.

### Guiding Question 1 (Quick Guide):

What are potential **links** between your discipline and **SD**?



	Environment	Society	Economy
	Natural resources (as the basis of livelihoods), climate change, energy consumption, waste production and recycling, ...	Independence/dependencies of individuals, societal structures, inclusive development, migration, knowledge, education, health, well-being, ...	Livelihoods, poverty, future of labour, inequalities, migration, economic & political power relations, globalization, ...
Research Topics			
Research Methodology			
Theory			
Application			

**Figure 10:** Analysis raster to determine potential links between a scientific discipline and SD (K. Herweg)

- What potential effects may research findings and/or their application in your discipline have, directly and indirectly, on the three dimensions of SD (environment, society, economy)?
- Who, in the global North and South, will probably benefit from your research, and who will not?
- With which disciplines should or could you potentially collaborate to address “wicked sustainability problems”, which cannot be solved within the boundaries of your discipline?

### 3.2.2 Graduates' future fields of work

The second Quick-Guide question seems more common for vocational schools and universities of applied sciences. But we recommend for all higher education institutions to start thinking from a graduate's perspective, and not from the perspective of a lecturer who wants to transfer knowledge.

#### Guiding Question 2 (Quick Guide):

What **fields of work** will the graduates enter?



What fields of work are you preparing your students for? Are you assuming that many will remain in academia, or do you also envisage them taking their academic training and its systematic approaches into various other jobs? We recommend keeping in mind that a number of key positions in education, consulting, planning, the private sector, industry, law, public administration, civil society, etc., have tremendous potential to contribute to SD in many ways.

### 3.3 Meso Level: the Individual Modules

Having answered the first two questions in the Quick Guide, we can now define more specific meso-level (module) competences that match the macro-level qualification profile. A module can be composed of different courses, all of which contribute to helping learners develop the module competences. The objectives for individual courses are the learning outcomes. They are formulated more concretely in combination with the content, in a process described in 3.4.2.

#### Social Anthropology 2 Competences for migration research

- Develop questions of social anthropological research
- Use qualitative methods for research
- Plan and carry out social anthropological research projects
- Present research results as posters



#### Pieces of a puzzle

As noted, terminology to describe an ideal-typical study programme (Figure 9) may differ, depending on institution and context. Whatever the levels are called, we recommend using the basic idea of a hierarchy. In a perfectly coordinated study programme (which is rare, unfortunately), different courses form a module and several modules form the whole programme. Think of it as a jigsaw puzzle in which all the pieces fit together. This puzzle should also be reflected in the definition of goals at different levels: taken together, several complementary "learning outcomes" should result in a more generally formulated "module competence". In turn, all "module competences" together should then result in the overall, summarized "qualification profile" of the study programme.

#### Mock modularization

Reality, however, often looks different. Many study programme reforms in the past decades rejected the idea of true modularization, i.e. a reasonable bundling of courses into modules. What used to be a lecture or seminar, for example, was often simply *renamed* as a module. This often led to an increase in the number of exams. It was forgotten that the basic idea was to conduct module exams in a competence-oriented manner instead of assessing students for each course separately.

#### Advantages of true modularization

True modularization has another major advantage in terms of programme planning. Even if individual courses are changed or replaced, the basic structure of the programme remains the same. It becomes possible to make slight changes to the course content, provided that the new course contributes to the development of the module competences. This also makes it easier to accommodate turnover in teaching staff. New staff can put their personal emphasis on content as long as it is in line with the overarching module competences. From this point of view, a truly modularized programme structure can also be seen as a dynamic equilibrium.

### Supervised self-study (SSS)

A large part of the learning process takes place outside of the organized courses. Ideally, however, learners are given goal-oriented assignments for self-study that are linked to the in-person meetings. This is why, in Figure 9, supervised self-study is designed as part of the modules. In best practice, it also establishes a connection between the courses of a module, which is why SSS is visualized across courses.

### Agreements and framework

For the above reasons it makes sense to be involved in the development of the overall study programme, even if you are “only” responsible for one course. This makes it easier to coordinate and reach agreement among members of the teaching team, because everyone is aware of each other’s views and agendas. The model programme architecture serves as a helpful blueprint for teachers who want to design their course as a precisely fitting piece of the puzzle. Adhering to this simple structure increases the likelihood of a consistent study programme.

#### 3.3.1 Typical situations

##### Guiding Question 3 (Quick Guide):

What **typical situations** will students have to **master** within these fields of work?



In order to design modules and courses that can build the competences required for SD (knowledge, skills, critical awareness), it is essential to imagine, as concretely as possible, different work situations and challenges graduates may have to master in their future jobs. It need not be a complete list of challenges, but it can make a difference if lecturers spend some time anticipating a range of *typical situations*. This serves to identify and critically review assumptions about what our students will encounter in real life, and will thus help to concretize the challenges for which we have to prepare them.

A series of “typical work situations” may begin with a *complex problem analysis* of a given work context involving environmental, sociocultural, and economic aspects. This can apply to any of the future fields of work listed in Chapter 3.2.2 – education, consulting, planning, the private sector, industry, law, public administration, civil society. A complex problem analysis commonly serves to *develop solutions* that are simultaneously ecologically sound, socioculturally acceptable, and economically viable. Solving such tasks often requires *managing an interdisciplinary team* on the one hand, and, on the other, *maintaining frequent and clear communication* with various societal actors. This involves that a team leader has to ensure that different perspectives are being considered and discussed, and that *literature* and other documents are consulted. The team possibly develops *several future scenarios* (e.g. “rich pictures”) of a more sustainable situation, perhaps by formulating a *complex set of impact hypotheses*. Finally, the team jointly *decides* and writes a *team report* under *time pressure* and often with *incomplete information* and several knowledge gaps.

##### Planning an education module: imagine a “typical work situation”

You are the leader of an interdisciplinary team of five scientists from various disciplines. You have a few background documents describing a problematic situation from six different actor perspectives (farmers, local decision-makers, etc.). After conducting additional literature reviews, you formulate a problem diagnosis description of maximum two pages, including the main actors, their problem perspectives, their conflicts of interest, and their power relationships, etc.



It is probably not possible to formulate a precise real-world situation for educational purposes unless the lecturer has practical experience. However, any attempt to incorporate a real-world case into an educational setting increases the probability of building competences that are relevant in SD contexts. The modular arrangement of courses provides the opportunity to address different elements of a “typical situation to master” with different teaching–learning arrangements (Chapter 3.4.3).

While many students ask themselves how to find a job after graduation, many courses still focus on knowledge transfer. To imagine **typical situations** that graduates will have to master can be a useful exercise not only to condense contents (Chapter 4.4), but also to build up other competences and intrapersonal resources relevant for professional life.



Cartoon 13: Typical Situations – new graduate meets old hand (Illustration: K. Herweg)

### 3.3.2 Required competences

#### Guiding Question 4 (Quick Guide):

What **competences** do students need to master these situations?



#### Generating an “action competence model” for ESD

We can now generate an “action competence model” while taking into account definitions of “competence” that are directed towards *understanding* SD contexts, but also *acting to solve* issues of unsustainability. A reference framework on key competences for sustainability for academic programme development by Wiek et al. (2011) is probably the most widely known in the scientific community. Wiek et al. define five key competences in sustainability: “Systems-thinking competence, Anticipatory competence, Normative competence, Strategic competence, and Interpersonal competence”. According to the Delphy study conducted by Brundiers et al. (2020), experts generally agree on Wiek’s reference framework but propose a hierarchy and two additional key competences: “intrapersonal and implementation competences”. In 2012, the United Nations also defined competences for ESD, grouped into four categories: “learning to know, learning to do, learning to be, and learning to live together” (UNECE 2012). Each of these competences contains the common characteristics of taking a holistic approach, envisioning change, and achieving transformation.

### Pragmatic framework to define ESD competences

Our action competence model presented in Figure 13 and Table 1 below takes into account the discussion of competences for ESD, but it is based on and adapted from our own practical experience. On the one hand, we prefer a clear distinction of competence categories. In the 1970s, an important idea still widely accepted today was put forward by the German educational researcher, Heinrich Roth. He argued that in order to shape our world, not only “professional competence” in the sense of factual knowledge is important (handling the subject), but also social competence (handling others) and “personal competence” (handling oneself) (Roth 1971). Many important subsequent competence models refer to this idea (e.g. Weinert 2002, Rychen 2008). On the other hand, our model considers the traditional triad of pillars described below, “academic knowledge, professional skills, and critical awareness” (Figure 11; see Chapter 3.1.1).



**Figure 11:** The traditional triad of essential areas of development in holistic education and training programmes (Design: K. Herweg)

### Academic knowledge for ESD

The three categories of knowledge relevant for ESD are the same as those used in transdisciplinary research (Chapter 1.3; and Figure 12):

- **Systems knowledge:** Knowledge about complex social, economic, and ecological interrelationships and their interacting effects. In other words: understanding how the *system* – i.e. the complex interactions between environment, society, and economy – works.
- **Target knowledge:** Knowledge about relevant objectives, including how these objectives are selected over others (i.e. justifying selection, prioritizing objectives). Science can provide direction for steering towards SD.
- **Transformation knowledge:** Knowledge about realistic solutions, options for action, strategies, and measures. Scientific contributions, e.g. in the form of rules, solutions, measures, cultural practices, or technologies to promote SD. Transformation knowledge includes monitoring and reviewing the achievement of goals, using disciplinary and interdisciplinary scientific methods.

### Professional skills for ESD

The professional skills needed for ESD are diverse and situation-dependent. They are anchored in the standard educational programme of each discipline. They include the ability to compose target-group oriented texts while remaining factually sound and constructive, processing data using spreadsheets or statistics programmes, and finding ways of presenting data visually. Other basic skills include researching and evaluating relevant information, as well as mastering communication technology or subject-specific methods for data collection. In ESD, these mainly disciplinary professional skills must be supplemented by inter- and transdisciplinary skills, examples of which are listed in Table 1.

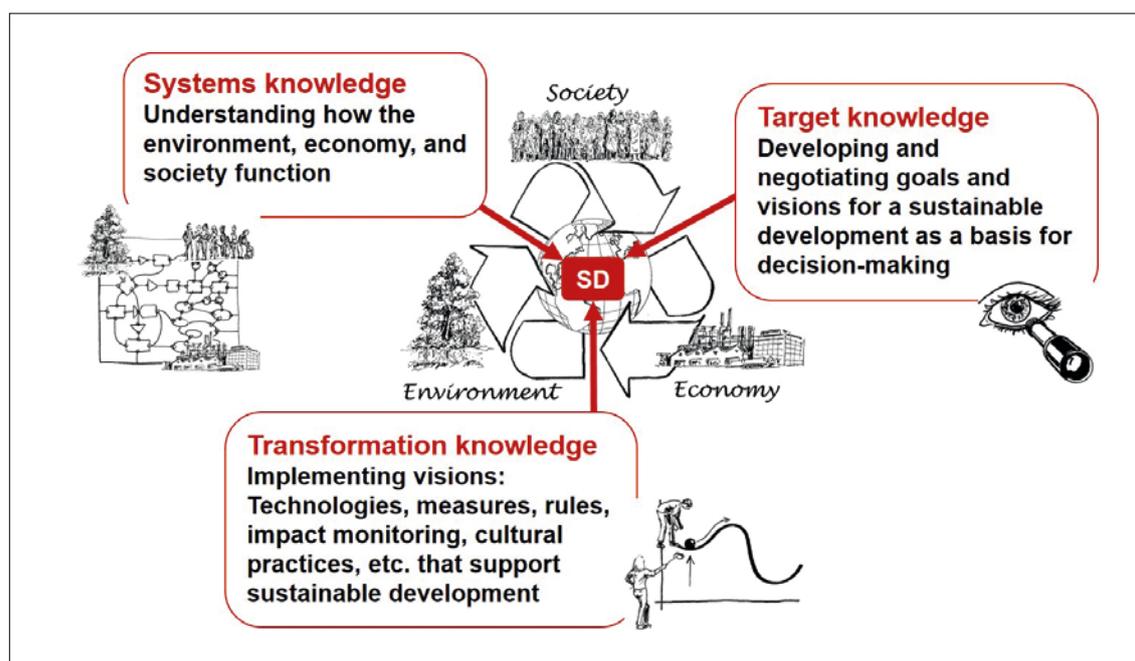


Figure 12: Types of knowledge (Design: K. Herweg)

### Critical awareness for ESD

Gaining critical awareness enables people to question and critically assess the subjective theories (world-views, ideas, opinions, beliefs, convictions, etc.) that they developed through their socialization, e.g. within their family, circle of friends, etc. Critical awareness gives them the ability to critically reflect and put these personal convictions into perspective by comparing and contrasting them with scientific theories, and drawing valuable conclusions for their actions. This is a cardinal goal, especially in higher education. Action should primarily be guided not by opinions, but by a professional, evidence-based attitude and consideration of relevant research results. The development of ethical points of reference, moral principles, and honest motives is highly relevant, especially in ESD, as are allowing doubts and dealing with uncertainties. The perfectly self-reflective personality may be very ambitious, but paving the way towards it is paramount.

In view of building “attitudes” and “values” for SD, Hattie (2011), Haversath (2012), Schubiger (2013), and Stoltenberg and Burandt (2014) provide a number of indications on how to explore pathways from competences to action. We have supplemented these based on our own experience. The following points are considered important to build up attitudes and values supporting engagement in SD, but they do not lead there automatically. Of course, it is also important for the lecturer to demonstrate that they are sincere about and personally engaged in the topic as well.

- Feeling injustice, consternation, empathy, and solidarity with disadvantaged people, species, marginalized sustainability dimensions, etc. can increase the motivation to engage in SD, develop an ownership for action, and develop a sense of responsibility and moral obligation.
- Examples relating to students’ contexts and experiences make it easier for them to access SD (small psychological distance).
- Doubts, difficulties, searching, critical experience, etc. can trigger reflection processes by the students. These may e.g. reveal contradictions between one’s norms and values and one’s behaviour, which is a precondition to change one’s mindsets and behaviour.
- SD is solution-oriented, which means that learning from problems is essential, but focusing on solutions is more effective, in terms of increasing the expectation of self-efficacy (i.e. one’s own positive impact).
- Students’ envisaged actions towards SD may be blocked if they are not compatible with their social context (family, friends); making such contradictions transparent can help overcome these blockages.

Competence is the ability to *mobilize resources* for solving problems and challenges in life in specific contexts, leading to specific performances (Le Boterf 2015). Further inspired by Wilhelm et al. (2019), we take up this idea to introduce a model (Figure 13) which may be used as a framework for defining competences (see Euler and Hahn 2007) at both macro and meso level. This action competence model may help you to develop an education and training strategy for sustainable development.

<b>Action Competence Model</b>	<b>Academic Knowledge</b> <i>knowing about ...</i>	<b>Professional Skills</b> <i>ability to ...</i>	<b>Critical Awareness</b> <i>attitude / values; willingness to consider ...</i>
<b>Professional Competence</b> <i>(handling the subject)</i>			
<b>Social Competence</b> <i>handling others)</i>			
<b>Personal Competence</b> <i>(handling oneself)</i>			

**Intrapersonal Resources**

**Figure 13:** Action Competence Model (Design: K. Herweg)

**Filling in the framework: intrapersonal resources**

The nine white fields are for intrapersonal resources, i.e. the individual building blocks that make up the envisaged competences. These resources are needed to master typical work situations (Chapter 3.3.1) and should be built up during the training.

Intrapersonal resources include the aforementioned triad of academic knowledge, professional skills, and critical awareness. The first column (academic knowledge) contains theories, concepts, and models to be learned. The second column (professional skills) contains the skills that must be mastered, including techniques and methods. And the third column (critical awareness) contains the desired attitudes and values that must be refined through structured self-reflection or through a discourse with others.

Table 1 lists examples of intrapersonal resources that are relevant for ESD. In the extensive literature on ESD they are often referred to as “competences”, which however makes it difficult to synthesise these models because the term “competences” is not used consistently. It may refer to knowledge, or skills, or critical awareness – or even a mix of these. In this book, therefore, we want to make a clear distinction and prefer the term *intrapersonal resources*. It is important to point out that they are *components of competences*, meaning that we regard them as competences only *in combination*. Please note that the examples of intrapersonal resources in Table 1 are not meant to be achieved all in one course, but at the levels of modules or even study programmes.

**Intrapersonal resources** include **academic knowledge, professional skills, and critical awareness**. They are individual building blocks of competences that, together, make up the competences needed for ESD.



**Table 1:** Action Competence Model containing examples of intrapersonal resources relevant in ESD (K. Herweg)

<b>Action Competence Model</b>	<b>Academic Knowledge</b> <i>knowing about ...</i>	<b>Professional Skills</b> <i>ability to ...</i>	<b>Critical Awareness</b> <i>attitude / values;</i> <i>willingness to consider ...</i>
<b>Professional Competence</b> <i>(handling the subject)</i>	<ul style="list-style-type: none"> <li>• systems, targets, and transformations</li> <li>• theories, concepts, models, and facts of sustainability science</li> <li>• causes and consequences of unsustainable development (from global to local scales)</li> <li>• different visions of SD</li> <li>• concepts and tools of project / programme management</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• analyse problems holistically (environmental, sociocultural, and economic dimensions)</li> <li>• assess uncertainties, risks, and potentials of solutions (comprehensive impact hypotheses)</li> <li>• manage incomplete knowledge and uncertainties in complex systems</li> <li>• apply inter- and transdisciplinary monitoring and assessment methods</li> <li>• strive for sustainable solutions and action</li> <li>• develop innovative procedures and solutions</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• ethical guidelines</li> <li>• environmental and societal perspectives (interdisciplinarity)</li> <li>• topics of societal relevance</li> <li>• sustainable solutions and action</li> <li>• innovation</li> <li>• ...</li> </ul>
<b>Social Competence</b> <i>handling others</i>	<ul style="list-style-type: none"> <li>• basic concepts of social psychology and cultural anthropology</li> <li>• concepts of justice</li> <li>• "other" scientific epistemologies</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• initiate constructive interactions</li> <li>• assume responsibility in teamwork</li> <li>• motivate others</li> <li>• handle conflicts professionally</li> <li>• put oneself in the shoes of others</li> <li>• master means of communication</li> <li>• describe complex subjects to a specific target group</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• empathy</li> <li>• others people's know-how, values, and attitudes</li> <li>• engagement in social learning situations</li> <li>• international, intercultural, and interdisciplinary cooperation</li> <li>• moral action</li> <li>• decision-making on principles of justice</li> <li>• ...</li> </ul>
<b>Personal Competence</b> <i>(handling oneself)</i>	<ul style="list-style-type: none"> <li>• metacognition (thinking about one's thinking)</li> <li>• individual learning processes</li> <li>• own ethical principles</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• master metacognitive strategies</li> <li>• manage time</li> <li>• ...</li> </ul>	<ul style="list-style-type: none"> <li>• critical self-reflection</li> <li>• one's own knowledge gaps</li> <li>• personal flexibility</li> <li>• personal frustration tolerance</li> <li>• open-mindedness</li> <li>• cosmopolitanism</li> <li>• expectations of self-efficacy</li> <li>• personal transformation</li> <li>• ...</li> </ul>

### Defining competences for ESD: an example

We hope that the objectives of education and training programmes for sustainable development are gradually becoming clearer. In future-oriented programmes, motivated people develop their competences in order to make positive contributions to a changing world. There is no need to paint a picture of an unattainable utopia. Less complex situations can already be targeted during training or further education. As a starting point, take the following example of a specific situation at a university.

**Paperless study** 

Please note that not all nine fields are equally relevant for every course. To illustrate this, here is a simple example: A student has learned that her university is aiming, within two years, to provide all learning materials in digitalized form to reduce the mountain of printouts and save on natural resources. The student is very environmentally aware and believes however that the university has not taken into account that many natural resources are used and rare raw materials mined for the production of mobile devices, often under catastrophic conditions for workers and nature. Child labour still exists and there are vast amounts of electronic waste. The student thus wants to write a statement addressed at the university administration. What skills does she need for this? Table 2 contains a selection.

**Table 2: Framework for defining competences needed for the above example, "Paperless study" (K. Herweg)**

<b>Action Competence Model</b>	<b>Academic Knowledge</b> <i>knowing about ...</i>	<b>Professional Skills</b> <i>ability to ...</i>	<b>Critical Awareness</b> <i>attitude / values; willingness to consider ...</i>
<b>Professional Competence</b> <i>(handling the subject)</i>	<ul style="list-style-type: none"> <li>• production conditions</li> <li>• energy consumption</li> <li>• supply chains and cost of print materials compared to electronic content and hardware</li> </ul>	<ul style="list-style-type: none"> <li>• gather information</li> <li>• analyse sources</li> <li>• perform calculations</li> <li>• write texts</li> </ul>	<ul style="list-style-type: none"> <li>• multi-perspectivity</li> <li>• problem awareness</li> <li>• anticipation</li> </ul>
<b>Social Competence</b> <i>handling others</i>	<ul style="list-style-type: none"> <li>• hierarchical levels and roles within a university</li> </ul>	<ul style="list-style-type: none"> <li>• communicate effectively, both orally and in writing</li> <li>• carry out interviews</li> </ul>	<ul style="list-style-type: none"> <li>• empathy</li> <li>• responsibility</li> <li>• resource orientation</li> <li>• cultural relativism</li> </ul>
<b>Personal Competence</b> <i>(handling oneself)</i>	<ul style="list-style-type: none"> <li>• awareness of own prior thematic knowledge and gaps in this knowledge</li> </ul>	<ul style="list-style-type: none"> <li>• manage one's time</li> </ul>	<ul style="list-style-type: none"> <li>• reflection on one's own behaviour (i.e. in terms of the purchase and use of electronic devices)</li> <li>• self-efficacy expectation / conviction of control</li> </ul>

The white cells contain examples of intrapersonal resources that can easily be supplemented or adapted, depending on the situation. A target matrix like this can be developed as a basis for a study programme, starting from a specific situation that is strongly linked to reality. This might involve defining several prototypical situations that students may encounter in their future fields of work.

### 3.4 Micro Level: Developing Evidence-Based Courses

In the previous sections we discussed the context of ESD and guiding ideas for study programme design. We now turn to the design of individual courses. Planning a course is an iterative rather than linear process. However, learning outcomes remain at the core, because ultimately, as the course developer you must keep taking into account what the target group needs to master at the end.

#### 3.4.1 Basic organizational conditions of the course

**Guiding Question 5 (Quick Guide):**

What are the **basic organizational conditions** of the course, in terms of both teaching and target group?



How many students will attend the course, what is their educational level and previous knowledge, what infrastructure do they have access to, and what are their expectations and attitudes? A first step is to look at the initial teaching conditions before planning a course. Where will the course take place? To ensure that intended teaching-learning scenarios can be carried out as planned, it is important to clarify – and if

necessary, question – conditions like environment, premises, infrastructure, technology, furniture, etc. The course context is also important: in other words, what overall goals (e.g. module competences, qualification profile) should the course be aligned with? The following checklists can help you to analyse the conditions surrounding the course.

#### Checklist: Analysis of teaching conditions

- **Resources:** What financial and human resources are available for development, implementation, and evaluation? Can e.g. assistants, colleagues, or experts be involved in the process?
- **Infrastructure:** What are the learning locations? What infrastructure is available (media and equipment, software and hardware)?
- **Time frame:** What are the temporal and organizational conditions surrounding the course? (i.e. time it takes to develop the course, weekly time slot of the course, duration of course etc.)
- **Course context:** In what working and/or learning context will the course be embedded? What does the overall programme look like?
- **Preparations:** Is there already material available that can be used? Was a needs assessment with the target group carried out? Are strategies or drafts available?

#### Analysing the target group

Knowing the prerequisites of the target group is essential to conceptualize a tailor-made offer. Information can be obtained in various ways about what the students should already be able to do, what their motives and working attitudes are, and whether they are taking the course voluntarily or as a compulsory requirement, etc. Target group analysis is of course easier in regular courses with a homogeneous group of students. In ESD, by contrast, the analysis of the target group is particularly important, because, as explained in Chapter 1, the context of SD is best managed through an inter- and transdisciplinary approach. This usually means that the heterogeneity of the target group is high, as the participants' prior knowledge and experience in the relevant disciplines varies. In addition, a serious, advance target group analysis allows you to actively use participants' prior knowledge and experience during the course. The better the lecturer knows the target group, the better they can tailor their teaching concept.

The checklist below summarizes some important aspects of target group analysis. Relevant information can be obtained through document analysis (e.g. qualification profiles), interviews, questionnaires, observation, labour market analysis (future fields of work), expert interviews, or from previous experience with similar groups.

#### Checklist: Analysis of target group

- **Demographic data:** Age composition / gender distribution / educational qualifications / type of occupation / geographical distribution / number of participants / etc.
- **Learning situation:** Voluntary participation / who finances participation / time budget / place of learning / balance of family and professional life / access to media and technical infrastructure / internet connection / etc.
- **Prior knowledge and experience:** General knowledge / previous knowledge related to the learning content / (professional) practical experience related to the learning content / learning habits / experience with different learning methods and learning techniques / previous knowledge and experience with different learning media / etc.
- **Expectations and attitudes:** Reasons for participation / expectations of the learning content / subjective learning goals / attitudes towards learning in general / attitudes towards certain forms of learning / attitudes towards the learning content and learning goals / etc.

This information can help to create a target group profile and to determine, for example, the homogeneity of the group. Even little information about the target group can lead to useful conclusions: for example, if the students already have a packed course schedule, course content may need to be condensed. If participants have a lot of previous experience (e.g. practice-related), course contents should try to include this or link to it. If reasons for participation or expectations differ widely among the group, interest-based learning groups might be the solution.

In ESD, analysing the various **disciplines studied by participants** is particularly important, because it reveals different perspectives and gives the course an interdisciplinary perspective.



### 3.4.2 Constructive alignment 1: Learning outcomes

#### Guiding Question 6 (Quick Guide): Constructive Alignment 1

What are the intended learning outcomes?



#### Learning outcomes + corresponding assessment criteria = teacher clarity

New Zealand educational researcher John Hattie calls the combination of learning outcomes and corresponding assessment criteria “*teacher clarity*” (Hattie 2012). In contrast to the programme or module level, at the course level, successful teachers define the intended learning outcomes precisely. Learning outcomes are formulated as statements about what a learner knows, is able to do, and the status of their critical awareness after completing a learning process. Clear learning outcomes are formulated in an action-oriented way and include specific “intellectual” exercises, such as analysing texts, formulating conclusions, developing concepts, etc. In addition, assessment criteria need to be derived from the learning outcomes. In this way it is clear at the start which tasks the learners must master by the end of the course, and to what level of expertise. Tasks must be sufficiently demanding but nonetheless accomplishable for the target group. Complex situations can be broken down into simpler tasks.

Defining good learning outcomes may be time-consuming at the start, but it makes subsequent planning of the course much easier. Well-formulated learning outcomes also prevent further “schoolification” of higher education: the clearer the goal, the easier it is to choose individual paths. And finally, having clear goals make form and content obvious. By the way, we have found that it is much easier to write good learning outcomes jointly with colleagues or experts.

**Learning outcomes** highlight what learners **know**, what they are **able to do**, and what their **status of critical awareness** is **after completing a course**. Formulating learning outcomes helps lecturers plan their lessons based on the output – i.e. the perspective of the students – rather than on the input (i.e. the contents of what lecturers plan to teach). Clear learning outcomes are formulated in an action-oriented way.



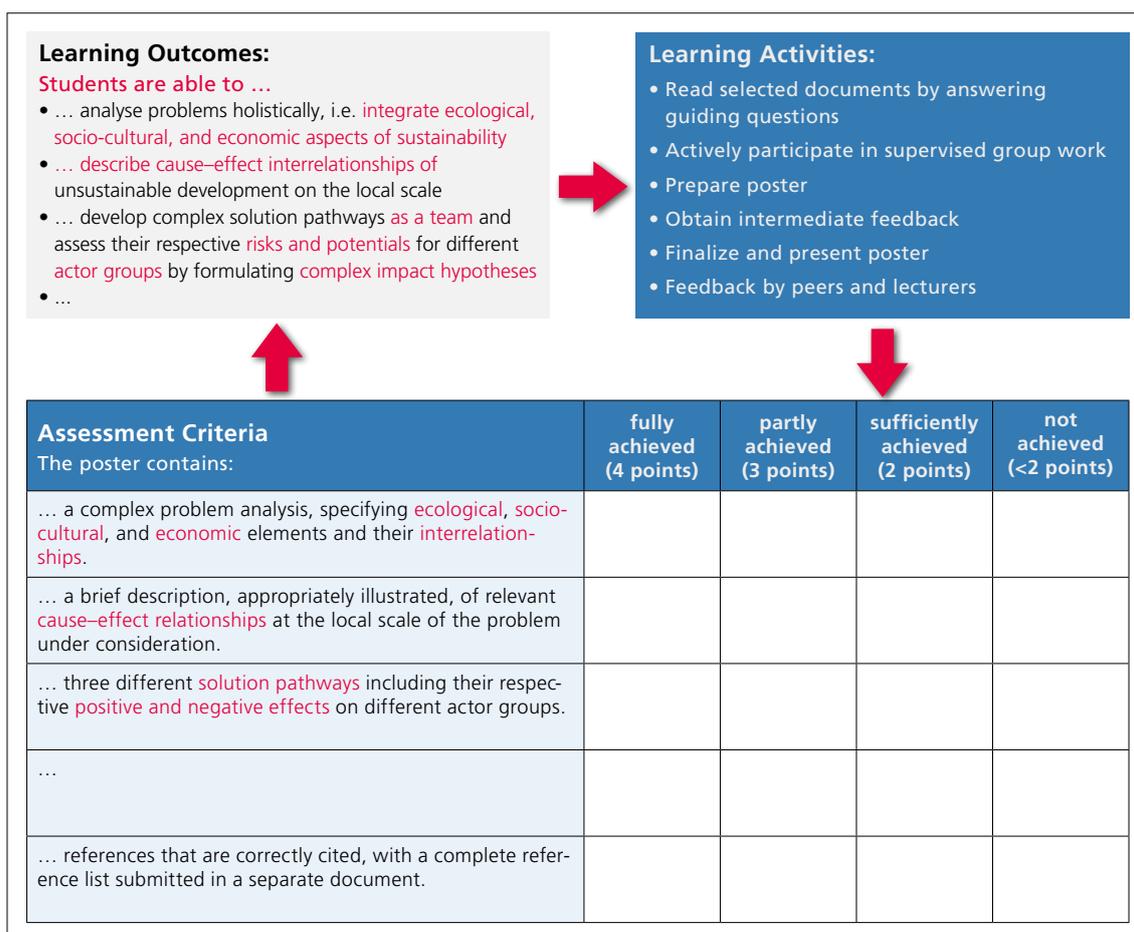
#### Assessment criteria

Clear criteria for assessing student performance are also important for transparency on students’ *expected performance* (Chapter 3.4.4). Only if assessment criteria reflect the intended learning outcomes can an assessment indicate whether the intended goals have been achieved. All elements of constructive alignment must be linked (Figure 14), in order to provide relevant information to students about what they will be measured against at the end of the learning process. According to Hattie (2012), “*teacher clarity*” is a proven, strong impact factor on academic achievement. Additionally, good learning outcomes generally form important filters for selecting relevant content out of the abundance of potential content.

#### Target level of learning outcomes

The definition of learning outcomes depends on the study programme cycle (Bachelor’s, Master’s, PhD) and on the level of expertise to be built in a module or course. Motivating targets should be challenging but achievable. What level of expertise is expected when mastering specific situations? Different target levels for the same types of tasks can be determined through clear definitions:

- **Remembering:** Facts, figures, essentials, etc. must be recognized or freely reproduced.
- **Understanding:** Concepts must be explained in own words.
- **Problem-solving:** Complexity must be analysed, and new models or procedures developed.



**Figure 14:** Linking learning outcomes, learning activities, and assessment criteria – an example (Design: K. Herweg)

Using appropriate active verbs when formulating learning outcomes can help to determine the desired target level (Table 3). Such models have a long tradition in education and are known as taxonomies. They now exist in large numbers, the most famous probably being *Bloom’s Taxonomy of Educational Objectives* for the cognitive domain, developed in the 1950s and revised in 2001 (Anderson and Krathwohl 2001). Its many levels have often been criticized as cumbersome and too fragmented for everyday teaching. We have created a condensed version for use in our teaching (Table 3).

**Table 3:** Useful active verbs to define learning outcomes at specific target levels (K. Herweg)

Required performance per level		Typical activities
<b>Remembering</b> recognizing and recalling information	<ul style="list-style-type: none"> <li>• recall information from memory (terms, facts, conventions, classifications, principles, methods, theories, concepts, models, etc. )</li> </ul>	reproduce, name, enumerate, designate, list, cite, indicate, draw, etc.
<b>Understanding</b> making connections, interpreting	<ul style="list-style-type: none"> <li>• link information</li> <li>• transform information (text to graph; graph to text, etc.)</li> <li>• capture interrelations</li> <li>• draw conclusions</li> </ul>	explain, describe, depict, translate, put into your own words, summarize, identify, compare, distinguish, interpret, conclude, etc.
<b>Problem-solving</b> evaluating and solving problems	<ul style="list-style-type: none"> <li>• transfer acquired knowledge to new situations (abstraction, generalization)</li> <li>• apply acquired knowledge in problem-solving</li> <li>• assess, evaluate, and weight complex information</li> <li>• estimate consequences</li> </ul>	execute, analyse, determine, propose, design, develop, justify, judge, generate, construct, criticize, verify, test, plan, produce, create, shape, elaborate, form, etc.

### Zone of proximal development

The “*zone of proximal development*” is an essential concept of the social-contextual theory of Lev Vygotsky. Having achieved a certain competence level in a specific area, the learner takes natural developmental steps into the adjacent, “higher” zone (Vygotsky 1934). This is the ideal learning zone in which to place tasks that can be mastered with support or guidance. If tasks are placed too far away from the current stage of development, the learner is overburdened and the likelihood of learning success is lower. What someone (e.g. a learning child) is able to perform with guidance, they will master in their own time later. In this concept, social interaction between teacher and learner is essential (Vygotsky 1981). Peers that are a bit more advanced can assume the role of tutor, which is an essential argument in favour of cooperative learning scenarios or a tutoring system. To progress, learners need to be “nudged” out of their comfort zone without being overwhelmed and falling into the panic zone (Figure 15). This is the starting point of transformative learning: the question of how the lecturer can design a teaching–learning arrangement that makes transformative moments more likely (Chapters 1, 1.5).

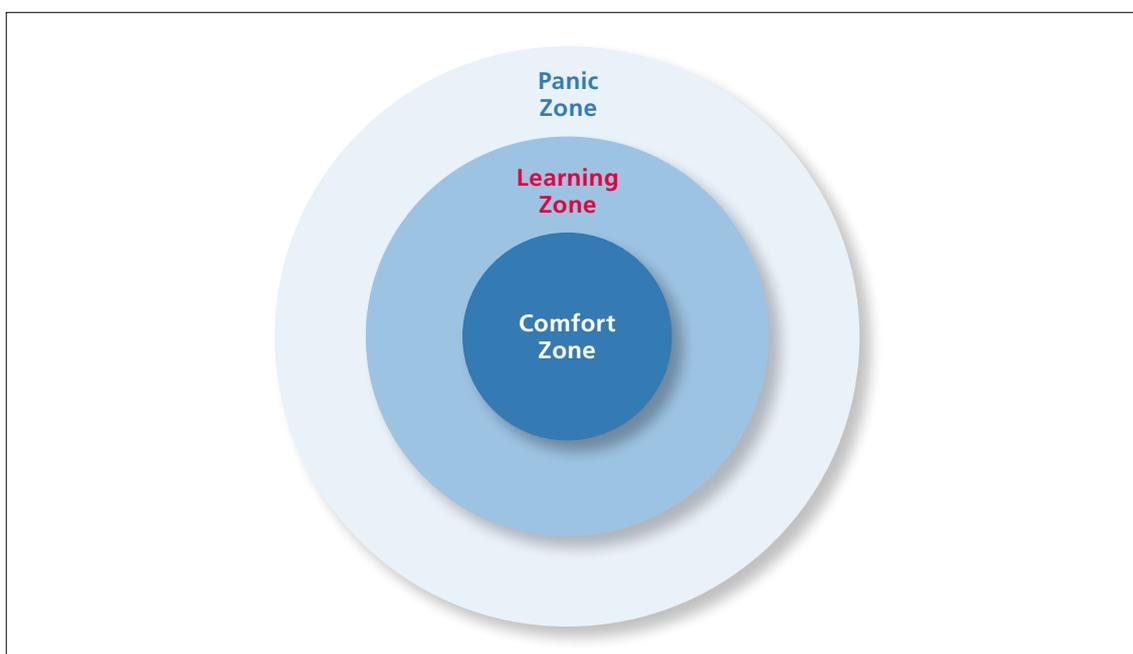


Figure 15: Zone of proximal development (Adapted from Vygotsky 1981 by K. Herweg)

Learning outcomes and assessment criteria must be linked, in order to provide relevant information to students about what they will be measured against at the end of the learning process. To make progress, learners need to be “nudged” out of their comfort zone without being overwhelmed and falling into the panic zone.



### Four steps to transparent expectations: SIMALECO

Having discussed the need for clear goals, we suggest four steps to formulate appropriate learning outcomes for your courses. The following simple process – following the acronym SIMALECO for easy retention – can help:

- 1) **Situation:** What is the main goal of the course? What should students be able to do by the end of the module or course, i.e. what competences should they have acquired? Which situations, either simple or more complex, should they be able to handle? Please bear in mind also interdisciplinary competences: finding and processing relevant information independently, communicating information and ideas to specific audiences, taking social and ethical aspects into account, etc.
- 2) **Manifestation:** What exactly do you expect from the learners? How will you know that students have mastered what is required? In what form does it become *visible* (manifest)? This is the basis for later feedback and points the way towards possible assessment formats.

- 3) **Level:** What level of expertise – what target level – do you expect? Should students only be able to list facts and terms; should they be able to explain concepts in their own words or transfer their knowledge to other subjects; should they be able to grasp contexts and draw conclusions; should they be able to assess complex issues; or should they develop something new altogether? These are all very different tasks.
- 4) **Communication:** How should expectations be made clear? We recommend that you formulate learning outcomes as action statements (can-do statements), i.e. specific actions you expect from the learners by the end of the course. This can also be “intellectual work”, such as analysing a text, forming hypotheses, or assessing a process. Communicate these statements clearly, as they will serve to guide the students. Note that this means avoiding the verbs “know” or “understand”, as these are not actions.

### 3.4.3 Constructive alignment 2: Learning activities

#### Guiding Question 6 (Quick Guide): Constructive Alignment 2

What **learning activities** will help students to achieve these learning outcomes? What **learning environments and teaching–learning arrangements** support creating spaces for transformative moments?



Teaching–learning arrangements can be, for example, lectures, seminars, exercises, block courses, projects, tutorials and much more. In the ideal-typical programme, several appropriately bundled courses form a module. The corresponding learning outcomes are formulated in a more specific way for every course. For the Social Anthropology study programme described in Chapter 3.2, for example, a lecture could be combined with a research-based project seminar, together forming a module. The corresponding learning outcomes could be shaped as follows:

#### Social Anthropology 3 Module including two courses

Learning outcomes for a Social Anthropology **lecture** entitled “Migration and research on migration” (Chapter 3.2)

At the end of the **lecture**, students are able to:

- name the major migration movements of the past two centuries
- explain central concepts of migration and migration research
- explain selected relevant models, theories, and methods of migration research
- name milestones in the history of migration research
- summarize the main findings of European and North American migration research

Learning outcomes for the corresponding research-based **project seminar** entitled “Migration research project seminar”

At the end of the **seminar**, students are able to:

- formulate research questions on migration according to scientific standards
- select the appropriate qualitative research method from a range of methods suited to specific research questions
- plan and conduct a problem-centred interview
- plan and conduct a narrative interview
- conduct an interview with experts on the topic of migration
- plan and conduct participant observation
- collect and analyse qualitative data using appropriate methods, and draw adequate conclusions
- condense analysed data on a scientific poster
- present their own migration research project and its results in a comprehensible way at a poster session.



To start off the process of designing the best possible teaching–learning arrangements, we suggest conducting the following short reflection:

Ask yourself the following questions:

1. As a **student**, in what kind of courses did you learn best or most?
2. As a **lecturer**, what types of courses do you mostly offer?

Mark your answers along the blue scale, and compare both positions. Does your experience as student match what you offer as a lecturer, or is there a difference?



<b>100% Practice</b>	<b>50/50</b>	<b>Theory 100%</b>	
<i>Fieldwork Internship</i>	<i>Exercises Group work</i>	<i>Seminars Literature work</i>	<i>Lectures</i>

Answering these questions may help you find a number of starting points from which to reflect on and improve existing courses. Going further, you may wish to include e.g. ideas of transformative learning and td learning. This will set you well on the way to creating spaces for transformative moments to arise (Chapter 1.5).

### **Transdisciplinary learning for SD: nine suggestions**

Based on our understanding of td research, in Chapter 1.5 we derived several principles to design td education. Based on these principles, we make nine suggestions for designing learning environments appropriate for courses focusing on SD.

How can you best apply the principles of td education to create spaces for transformative learning opportunities to arise? We assume that when planning your course, you are aware of SD-related topics and the knowledge you expect the students to acquire. The following nine suggestions therefore focus on building skills and critical awareness. We realize it may be difficult to organize inter- and transdisciplinary study programmes or courses within disciplinary settings, but we hope that the suggestions can encourage you to explore new ways and means beyond disciplinary settings. The suggestions are based on courses that were part of various study programmes in Geography and Sustainable Development, where not all lecturers were trained in didactics but nonetheless had to find innovative teaching–learning solutions. Over the years, we gradually improved these courses with regular evaluations by students, other (non-academic) actors involved, and lecturers.

#### *Work on a real-world context with complex problem settings; be solution-oriented*

After having identified a link between SD and your course (Chapter 3.2.1), SD-related topics can be incorporated into any course. Students gain awareness of the problem and become familiar with theories, conceptual frameworks, and literature, combined with solution-oriented exercises, in groups or individually. Particularly topics or examples relating to students' own contexts and experiences can help to create genuine interest.

#### *Bring together students from various disciplines*

An interdisciplinary team of students is an ideal composition to understand a large part of a complex social-ecological system (Chapter 1.3). In such a team, students can build interdisciplinary systems knowledge, and strengthen systems and anticipatory thinking (such as formulating impact hypotheses). A disciplinary group of students trying to cover complex topics will have considerable gaps in systems knowledge. Managing incomplete knowledge, knowledge gaps, and uncertainties in complex systems therefore requires teamwork and participation. Teamwork strengthens social competences, such as cooperation, motivating each other, managing team conflicts, adequate communication, etc. Interdisciplinary teamwork may additionally offer interesting insights into the diversity of epistemologies and help reflect implicit values related to how students view different scientific disciplines.

#### *Allow students to interact with actors from practice, e.g. through experiential learning outside the classroom*

Stimulate students' senses by taking them out of the classroom and into a real-world context through excursions, exploratory field surveys, field courses, etc. In our experience, such teaching–learning arrangements have the highest potential to allow transformative moments to arise (Chapter 1.5), as we expand on below.

### *Build on participation and cooperation*

Participation and cooperation – not competition – are key characteristics needed for SD (Chapters 1.2 and 1.4) and should therefore play a corresponding role in ESD. Interviews with societal actors could be conducted by phone or skype. However, it is more exciting to hold interviews or discussions face-to-face – ideally, in the actor’s own environment. Personal encounters with practitioners involve experiential learning, particularly when organized in a location outside the classroom that is familiar to the actors but unusual for students. Being in unknown territory has the potential to increase students’ mindfulness and attention. Interacting with practitioners may require a change in perspective and can trigger reflections on one’s own perspective. Having doubts and encountering difficulties are all part of the learning experience. This may uncover contradictions between one’s own norms and values and behaviour, which can constitute a “disorienting dilemma” and increase the likelihood of a transformative learning experience. These varied experiences give students several opportunities to explore the relevance for society of what they are doing, and thus increase the expectation of self-efficacy. Listening to narratives of people in their surroundings enhances openness to other perspectives, attitudes, and values.

### *Meet practitioners*

SD requires negotiating target knowledge (goals, justifications, priorities), and avoiding the dominance of powerful actor groups (Chapter 1.2). Working with societal actors means working with different value systems and revealing what transformation knowledge (measures, technologies, rules, etc.) is needed. Knowledge co-production in td research usually begins with a joint negotiation of research questions with societal actors (Chapter 1.3). This increases societal actors’ ownership in research, which in turn also motivates researchers to be part of socially-relevant research. Meeting practitioners strengthens students’ capacity to evaluate the effects that potential solutions will have on “real people’s” lives. In addition, discussing potentials and limitations of different technological or government interventions enhances students’ communication skills. By clearly communicating their own point of view or research results, they ensure conceptual clarity at the start and practice translating scientific jargon into understandable language. Precise and target-group oriented communication is an essential part of any work in SD after graduation.

### *Take a long-term perspective*

Any interaction with societal actors will involve additional time spent organizing, e.g. to identify contexts and topics relevant to one’s discipline, to find appropriate (scientific) material, and to arrange interviews with actors who are willing to meet the students. This investment pays off when establishing a long-term cooperation in a certain region, e.g. near the university. Such a long-term real-world lab enables in-depth examination of the subject or topic while combining research and education.

### *Have students play a more active role*

The inter- and transdisciplinary character of ESD is changing the roles of lecturers and students. It is virtually impossible to find specialists in the whole array of issues that interact to comprise a complex social-ecological context. Both lecturers and students have their fields of specialization; at the same time, they are laypeople in many others. A *student-centred approach*, in which students play an active role, puts everyone in a kind of peer-learning situation, which strengthens participation, flexibility, creativity, and a sense of responsibility. Lecturers are more experienced but not necessarily more knowledgeable, except in their own specialization, and so they also learn to move on uncertain ground. They switch roles from being instructors, to being tutors or coaches. The motto here is *less teaching – more learning* (Herweg et al. 2012).

### *Focus on jointly developed solutions*

SD involves understanding and shaping complex systems. In this respect, much can be learned from analysing and understanding problems. But students may easily feel overwhelmed if they assume that they have to find solutions for complex problems on their own, resulting in frustration and the misleading belief that they “cannot do anything for SD”. It is important to remember that the basic philosophy of td research is to elaborate potential solutions jointly with the actors involved in implementing them; it is not about science acting alone. Developing joint solutions in complex systems will likely involve various types of actors, from the farmer incorporating environmentally friendly technologies and the policymakers designing the regulations that support the implementation – to customers who are willing to pay higher prices for healthier products. This process of knowledge co-production usually involves several cycles of negotiation, tests, monitoring, evaluation, and adaptation. Providing the necessary coaching to ensure that this process also provides a fruitful learning environment for the students, is the responsibility of the lecturer.

### *Emotions can be a lever of change; do not ignore them!*

While emotions have no place in purely scientific debates, this is different in SD. SD is a value-laden process, making personal engagement in SD at least partly emotional engagement. It may begin with, for example, the feeling of injustice related to the marginalization of social groups, exploitation of nature, etc. A rational debate with other actors about injustice helps to build empathy and may trigger consternation, solidarity, and ownership. Emotions are an important driver of behaviour change and of transformation. Personal experience is a strong resource to create a sense of responsibility and moral obligation, to act ethically, or to develop motivation to act for oneself and others. SD is a continuous process of negotiation to identify trade-offs (compromises) that balance and harmonize multiple ecological, sociocultural, and economic interests, and solve target conflicts in consensus and peacefully (Chapter 1.2). In this process, emotions can be useful levers of change towards SD. The role of researchers is to apply a systematic (scientific) approach and achieve evidence-based assessment of contexts, potentials, and risks. Therefore, the aim is neither to ignore emotions nor to let them dominate the process. We need to be aware of them, discuss them, and combine them with evidence-based decision-making. A student's decision whether or not to personally and professionally engage in SD, and to what extent, may depend on whether or not this decision is compatible with their own social context, friends, family, etc. Also in this respect, it is useful to know how to combine emotions with rationale.

### Tips and tools for ESD

By now it is clear that an ESD context requires the design of competence-oriented teaching–learning arrangements (Chapter 3.1). This means accepting that skills and critical awareness (attitudes and values) are as important as knowledge. However, we are still experiencing knowledge transfer to be a major activity in university education. Research constantly increases the pool of knowledge and we wonder how we can include all the knowledge we consider important in our teaching. Building knowledge seems to compete with building the other resources. Nonetheless, in sustainability sciences we somehow need to find elegant ways to incorporate them all. In this respect, educational research provides many useful recommendations, summarized below. In Chapter 4 (Tips and Tools), we provide more details, strategies, tools, methods, and guidelines.

As we will see (Chapter 4.1), students' attention significantly diminishes after 20 minutes of knowledge input. This means that many courses need a different rhythmic order, i.e. greater variation in learning methods within the current teaching–learning arrangements. This brings us back to the question: how do we handle the growing wealth of content? There are methods to help us to consolidate or condense content and subject matter, and to help us develop a dramaturgy of alternating inputs and exercises, to better internalize and retrieve what is learned. A process of replacing the need to assume completeness – by separating *must have* and *nice to have* – increases clarity of mind and quality of the course.

Above, our nine suggestions for td learning promote a student-centred approach, giving students a more active role, more responsibility, and greater self-regulation in determining their learning process. This implies a variety of options to build knowledge, such as by putting greater emphasis on activating students' previous knowledge, or through peer learning processes in small groups or other forms of cooperative learning.

This leads us to the question: how we can optimally support students' learning processes? As we gradually move from lecturing to tutoring or coaching, we may rethink communication and feedback mechanisms that support students in continuously assessing their own learning progress. Learning from mistakes is not only an educational strategy; in td research and knowledge coproduction, it is the only way to make progress.

#### 3.4.4 Constructive alignment 3: Assessment

##### **Guiding Question 6 (Quick Guide): Constructive Alignment 3**

How will you assess whether students have achieved the learning outcomes?  
What **assessment** formats will help to determine incremental achievement of the intended competences?



### Examining gains in competence

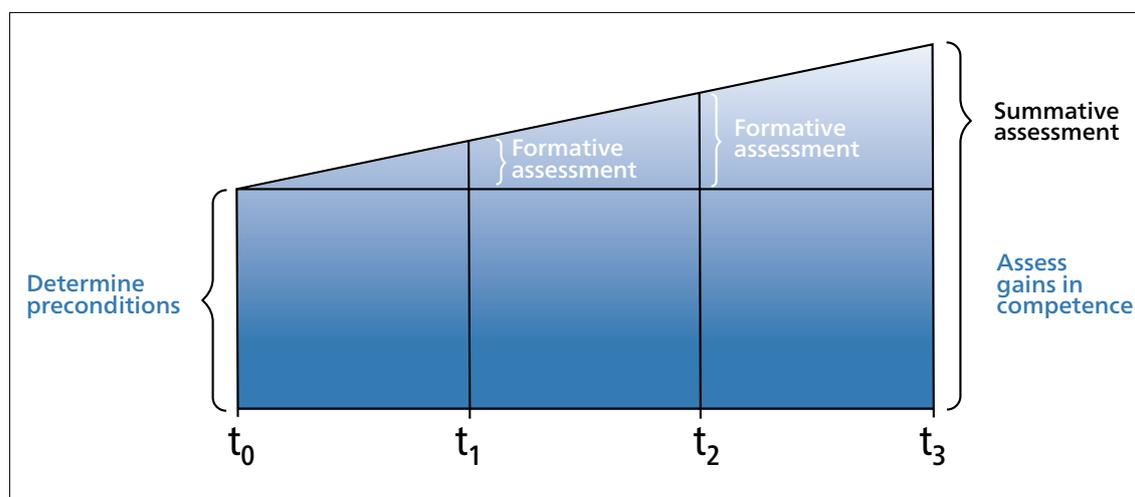
Assessment must be fair; an exam must be appropriate to test what was intended. Learning outcomes, learning activities, and assessment must form a unit. If you expect students to be able to solve complex problems at the end of the course, you must offer exercises that provide opportunities to gain problem-solving competence, and feedback. Presenting information in itself is not enough. This brings us back to the beginning, in particular to the definition of competences, learning outcomes, and target level. We are reminded of the importance of constructive alignment and that it is worthwhile including the assessment early on in the planning process.

### Assessment as an umbrella term

It is a fruitful strategy to develop educational programmes based on competence assessment, in a kind of didactic “reverse engineering”. Although the terms “assessment” or “assessment centre” have become established in human resource management in particular, assessment is used here as an umbrella term for all forms of assessing the acquisition of competence: tests, performance assessments, observation, exams, project reports, etc.

Assessing learning outcomes can have two primary functions (Figure 16):

- **Formative assessment:** These are assessments carried out during the learning process that help to determine the students’ progress. The results help to draw conclusions for the next learning steps, both for the student and for the teaching staff. Classroom assessment techniques (Chapter 4.5) are well suited for formative assessment.
- **Summative assessment:** A summative assessment takes place at the end of a course, unit, module, or entire degree programme, and counts towards the final grade. Learners are graded based on their results or receive a certificate for successful achievement. Ideally, of course, every summative assessment is also used formatively, for example through a debriefing following an examination, because *after the examination is before the examination*.



**Figure 16:** Formative and summative assessment of gains in competence

Students should not only be assessed at the end ( $t_3$ ). Ideally, several assessments should take place ( $t_1$ ,  $t_2$ ) (Design: K. Herweg)

### Test-enhanced learning with online quizzes

Test-enhanced learning applies what research underlines: when knowledge is recalled in tests, even where marks are not given, tests turn into learning events. Each time a certain piece of knowledge is recalled, it becomes better anchored in memory. Teachers familiar with this effect of pre-testing can use it and provide formative self-tests that analyse and simultaneously reactivate prior knowledge. These days it is easy and quick to create online self-tests with digital tools. Tests build a better base for subsequent input than re-reading a particular passage. This effect is even stronger where feedback is provided on the answers. Having individual knowledge gaps revealed contributes significantly to the development of metacognitive knowledge. Having students take an online survey before a course brings to light various aspects such as previous experience, prior knowledge, and motives for taking the course. It prepares participants for the subsequent in-person event and give teachers a better foundation for planning.

### Evidence of competence

Testing only knowledge of facts will show an incomplete picture, and so conventional multiple-choice questions will be inadequate to examine competences properly. The form of examination must be appropriate to reveal the competences acquired and to ensure constructive alignment between the various study programme levels. This may mean that application-oriented tasks such as case studies, projects, or research reports are more suitable for summative assessment of competences. As such formats are more time-consuming, they are unfortunately still too often neglected.

### Assessment formats

Contemporary teaching–learning arrangements call for contemporary assessment: in other words, going beyond regular multiple-choice tests. There are various different methods to assess performance or competence (Figure 17). On a general level, they can first be differentiated according to the form of presentation that learners have to demonstrate: oral, written, or action-based. A second dimension for classification can take into account the type of feedback and who provides it. Is it the teacher, an external expert, a computer programme, other fellow students, or the students themselves through self-assessment? In any case, assessments should be designed with the specific aim of testing the intended learning outcomes. Different means of cumulative assessment should also be considered, as final examinations are not always the appropriate method. It is important to select the right assessment method – i.e. the one that will best reveal the gains in competence in your particular teaching–learning arrangement.

		Feedback				
		self	peer	expert	software	...
Form of presentation	acting (e.g. lab analysis)					
	oral (e.g. presentation)					
	written (e.g. report)					

Assessment formats (methods)

Figure 17: A range of assessment formats is available; it is important to choose the one that will best reveal the gains in competence in your teaching–learning arrangement (Design: K. Herweg)

The assessment of learning outcomes has two primary functions: to determine the student’s learning development (**formative** function), and to assess overall performance at the end of a course (**summative** function). The form of examination must be appropriate to reveal the gains in competence and must ensure **constructive alignment** between the three core elements: learning outcomes, learning activities, and assessment.



There are various forms of assessment. To recap: constructive alignment involves three core elements: learning outcomes (competences), learning activities (teaching–learning arrangements), and assessment (of competences). When planning your course, module, or even study programme, it is essential that the learning outcomes match the assessment and vice versa. Some assessment formats are given below:

### Possible assessment formats

Students may

- **solve tasks:** students are given a task and expected to complete it using the correct method;
- **explain or define terms:** students use their own words to paraphrase terminology;
- **work on cases and problems:** students present real or constructed cases, outlining the problem-solving process that leads to a professionally adequate solution;
- **write essays, papers, technical texts:** students work on a research question according to scientific criteria and document it in a written paper;
- **write comments, summaries, reviews, statements** on books, articles, websites, programmes, etc;
- **keep learning diaries or learning journals:** students note how they have learned or what they are working on, and what they are still missing to achieve the learning outcomes;
- **create products:** students create a product (e.g. in the fields of fashion, design, computer science, engineering) that is evaluated based on predetermined criteria;
- **make comparisons:** students compare models, concepts, theories, texts, representations, etc., in writing or orally;
- **create concepts, models, or projects:** students create concepts/models that are evaluated based on predetermined criteria;
- **create learning portfolios:** students create a collection of products that document progress and development of competences. This supports self-directed learning and can be presented in oral or written form;
- **contribute to web-based discussions:** students write contributions to forums. Define criteria for content and minimum number of contributions in advance, ensuring that quality of the contributions remains key;
- **create visualizations:** students create a graph or diagram that represents the associations in thought between key concepts or content of the course and other concepts or content learned. Visualizations can also include concept maps, schemes, networks, concept clusters, and more;
- **hold poster sessions:** students design and present a poster on a selected topic;
- **produce summaries/conclusions of written discussions** (e.g. from forum contributions);
- **formulate (and defend) theses;**
- **take part in simulations or simulation games:** students test their practical skills in realistic, open scenarios;
- **conduct and comment on experiments** orally or in writing, individually or in groups;
- **take part in projects, individually or in teams:** students address application-oriented questions in projects. As a lecturer, look for identifiable individual contributions. Depending on the Learning Outcomes, project results and/or group processes (key competences) can be assessed;
- **develop questionnaires or report forms:** students develop questionnaires or forms for a specific situation or context;
- **reflect on lessons learned:** e.g. after an internship;
- **conduct self-tests** (written or computer-based) on learning content;
- **take part in Classroom Assessment Techniques:** e.g. Minute Paper, Muddiest Point, Analytic Memos, Concept Maps, One-Sentence Summary; and
- take part in **combinations of the above.**

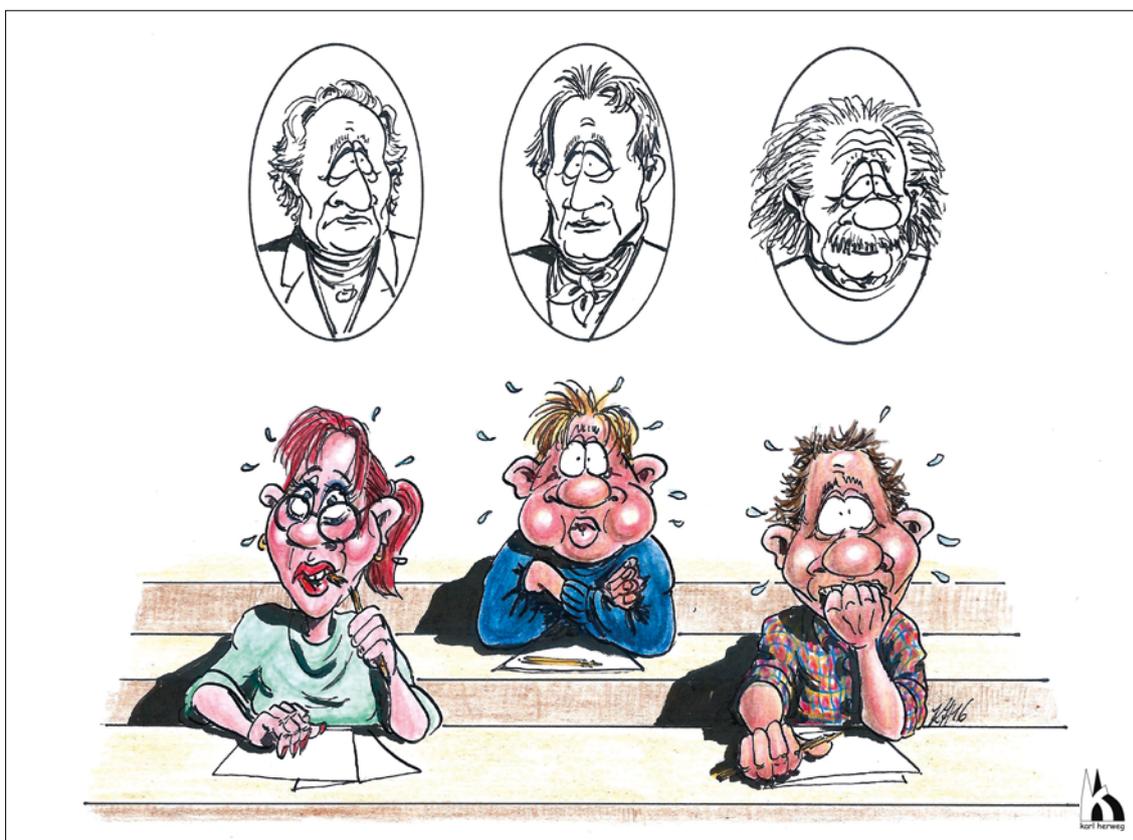


**Form of presentation:** The learner can demonstrate their acquired competence in different ways:

- Written work, documentation, poster
- Direct observation of practical activity
- Oral questioning by expert or oral examination
- Presentation, demonstration, lecture
- Combinations of these
- etc.

**Feedback:** Feedback can be provided by different agents:

- Teacher, Facilitator
- Expert
- Tutor, Coach, Supervisor
- Peer feedback: group members, course participants, etc.
- Internship supervisor
- Client (e.g. for external projects)
- Patients, clients
- Computer, test programme
- Self-assessment
- Combinations of these
- etc.



**Cartoon 14:** Assessment – Goethe is dead, Humboldt is dead, Einstein is dead ... and I'm not feeling so great myself (Illustration: K. Herweg)

### 3.4.5 How effective are your teaching–learning arrangements? Methods of evaluation

Just as students should be assessed on their learning development, teachers should be evaluated on their teaching strategies. In effective learning scenarios, mutual feedback through student assessments and teacher evaluations serves as a reciprocal control loop.

#### **Guiding Question 7 (Quick Guide):**

How and when will you **evaluate** the **effectiveness** of the teaching–learning arrangements and teaching strategies? What **transformative moments** could appear during the course?



#### **Formative evaluation**

It is beneficial for students and teachers to hold teacher evaluations periodically during the course. Known as formative evaluation, it provides information on whether teaching strategies are having the desired effects on learning. Successful teachers use different methods to obtain a picture of the effect their teaching is having on the current learning status of the students. They use the evaluations to draw conclusions about their teaching strategies and adapt them accordingly. The advantage of formative evaluations is that teachers still can use them to improve an ongoing course.

#### **Summative evaluation**

After the end of a course, its quality is reviewed in a summative evaluation. This type of review is more productive if an evaluation concept is already in place at the start of the course. This way, data can be collected during the course and processed at the end.

### Mutual feedback

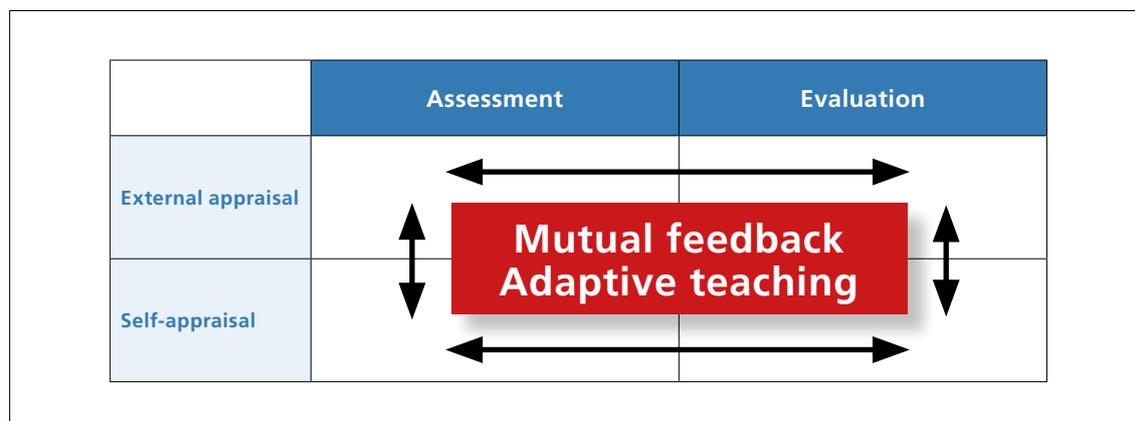
High-quality teaching–learning arrangements contain measures enabling continuous mutual feedback between lecturers and learners. Hattie and Timperley (2007) call this *informed judgement*. According to their research, informed judgement has a strong impact on learning success, because everyone is aware of who and what has contributed to progress and how. This allows next steps in a scenario of adaptive teaching to be planned jointly.

### D.I.E. for adaptive teaching

“Adaptive teaching” involves constantly reviewing the impact of teaching strategies in order to adapt them if necessary. Beyond the standard questionnaires, there is a variety of methods that can be used to collect appropriate data (Chapter 4). Ideally, results of the evaluation are discussed with the learners in order to achieve informed judgement and adapt the course jointly. Adaptive teaching might be pursued through the D.I.E. strategy of *diagnosis, intervention, and evaluation* (Hattie 2015). D.I.E. comprises a continuous cycle in which teachers diagnose the learning needs of the target audience, meet them with appropriate interventions, and then evaluate whether the desired effects have been triggered. If not, the interventions need to be adapted in the next cycle using alternative teaching strategies, content, support measures, etc. Good teachers thus keep their primary focus on the needs of the learners, and not only on the content. This has the added benefit of strengthening the relationship between teachers and learners. Hattie’s D.I.E. strategy is somewhat reminiscent of the well-known *Shewhart Cycle* (also known as the *Deming Circle*) with its *Plan-Do-Check-Act* (PDCA) phases. Such a control loop with continuous target–performance comparison is considered a guarantee of high-quality teaching–learning.

### Strategies for adaptive teaching

- Frequently assess learning gain using live polling or Classroom Assessment Techniques (CAT).
- In smaller seminar groups, collect brief oral feedback at the end of each lecture.
- Implement cumulative assessment (where a series of partial assignments together add up to the final assessment). Each partial assessment contains conclusions for the next assignment.



**Figure 18:** Efforts should be made to continuously improve the quality of teaching–learning arrangements by combining external and self-appraisal, assessment, and evaluation (Design: K. Herweg)

In high-quality teaching–learning arrangements, measures are implemented for **formative evaluation** (continuous **mutual feedback** between lecturers and learners) and **summative evaluation** (at the end of the course). **Adaptive teaching** involves constantly reviewing the impact of teaching strategies in order to adapt them if necessary (Figure 18).



### 3.5 Using the Action Competence Model for Planning

As mentioned before, the key is to be as specific as possible when formulating competences that are relevant to SD. Ideally, the path leads from the abstract to the tangible, as we will demonstrate using the term “systems thinking”.

Social-ecological systems research in SD (Chapter 1.3) teaches us that different elements (or subsystems) are interconnected in various ways. This means that we are not dealing with simple, linear, cause-effect relationships, but rather with a network, or system, of multiple interrelationships. One of the preconditions to handle such complexity is commonly referred to as “systems thinking”. Who would not want learners to be able to think in terms of systems? But what does that mean in practice?

It is easy to find typical situations in SD that require systems thinking. This brings us to *situational learning* or *situations as starting points* (Chapter 3.1.3). Starting from a typical situation, we can determine what module competences are necessary to master this particular situation. This, in turn, will enable us to specify what intrapersonal resources are needed. On a more tangible level, we can now formulate appropriate learning outcomes for each of the three competence areas (professional competence, social competence, and personal competence). And at the end, the assessment criteria must correspond to the intended learning outcomes.

For the sake of clarity, in the example below we focus on systems thinking and do not include statements for all potential intrapersonal resources. In this example we decided that systems thinking must relate to the integration of the three dimensions of sustainability – environmental, social, economic – and that this must be visible, like a thread weaving through all steps of the course procedure, from information collection to problem analysis, identification of solutions, and potential effects and side-effects.

**What exactly is “systems thinking”?**

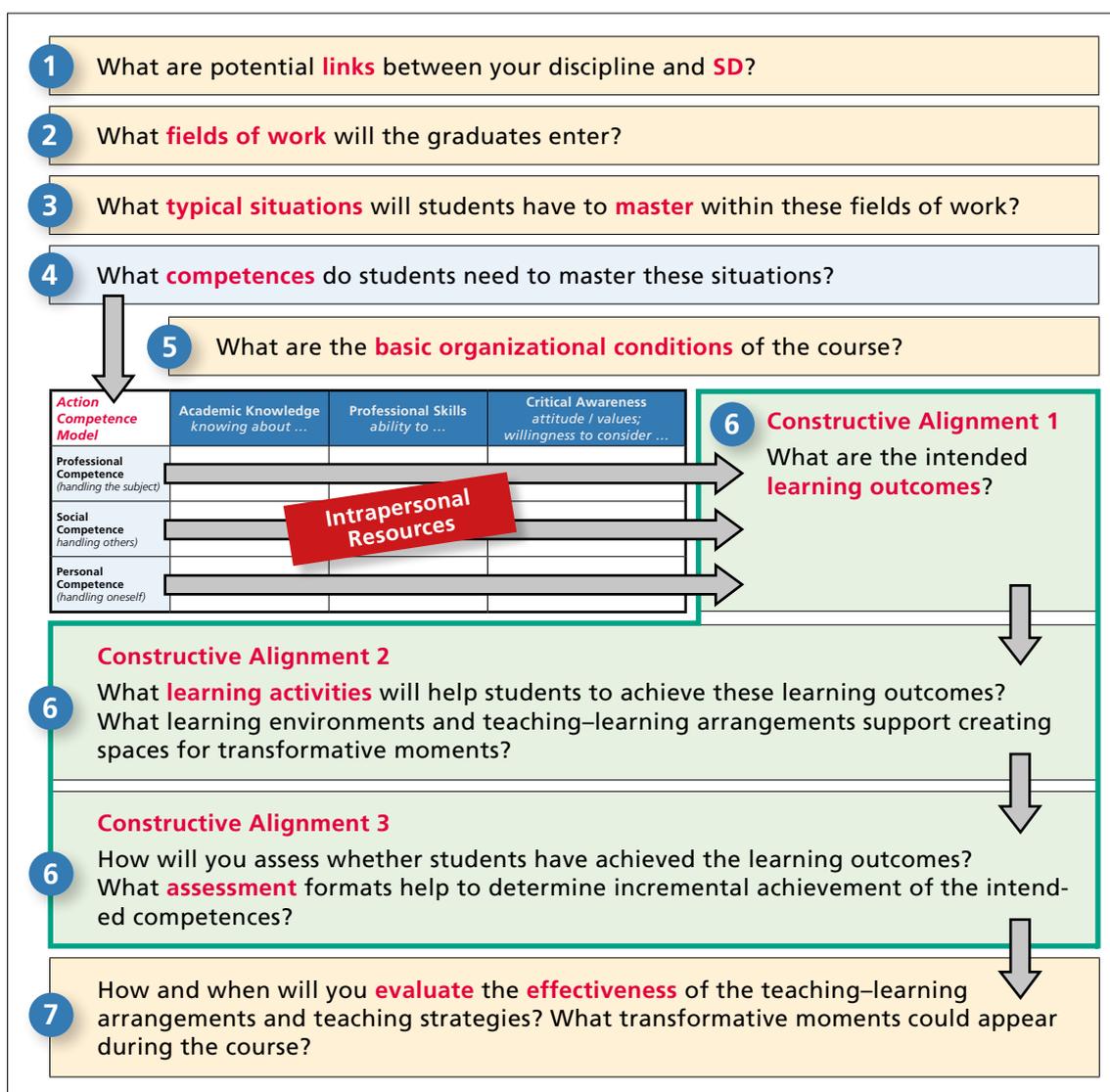
The following situation is our starting point (SSP):  
*After graduation, students must be in a position to carry out – as a team – an overall survey and assessment of the sustainability of, for example, different farming systems that strive to implement sustainable agriculture.*



<b>Module competence</b>	<ul style="list-style-type: none"> <li>• Integrate environmental, social, and economic dimensions into an overall conceptual framework</li> <li>• Master natural, social, and economic survey methods</li> <li>• Assess the sustainability of farming systems holistically</li> <li>• ...</li> </ul>
<b>Intrapersonal resources</b>	<ul style="list-style-type: none"> <li>• “Systems knowledge”: know about environmental, social, and economic dimensions of farming</li> <li>• “Skills”: be able to determine selected parameters in all three dimensions (methods)</li> <li>• “Critical awareness”: consider different environmental, social, and economic perspectives, attitudes, and values (interdisciplinarity)</li> <li>• ...</li> </ul>
<b>Learning outcomes</b>	<ul style="list-style-type: none"> <li>• “Professional competence”: determine connections of environmental, social, and economic factors of influence on sustainability of farms</li> <li>• “Social competence”: exchange results and write a group report that deals with the dimensions of sustainability in a holistic way, within the given time and length</li> <li>• “Personal competence”: consider own knowledge gaps in each of the dimensions of sustainability</li> <li>• ...</li> </ul>
<b>Assessment criteria</b>	<p>The report (poster, presentation, etc.) contains a ...</p> <ul style="list-style-type: none"> <li>• ... problem analysis in the form of a network analysis embracing ecological, social, and economic dimensions of sustainability</li> <li>• ... potential effects and side-effects of solutions on farmers in all sustainability dimensions</li> <li>• ...</li> </ul>

In previous Chapters we introduced a number of tools to design ESD from macro to micro level. How can we use them now to design actual study programmes, modules, and courses? To demonstrate one possible way of doing so, we combine three of the tools – the interrelated guiding questions (compiled in Chapter 2: “Quick Guide”), constructive alignment (see Chapter 3.1.4), and the action competence model (see Chapter 3.3.2). The guiding questions provide the basic structure of the matrix; the action competence model and constructive alignment are both embedded in this structure (Table 4). We include detailed examples of some of our courses in Chapter 5 to show how the matrix can be applied.

**Table 4:** Matrix for action competence-based planning, based on seven guiding questions (K. Herweg)



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## 4 Tips and Tools: Teaching–Learning Strategies for Active Learning



**Cartoon 15:** We are the students of today, attending the schools of yesterday, being taught by teachers of the past with methods from the Middle Ages, to solve the problems of tomorrow ... (Illustration: K. Herweg)

### 4.1 Cognitive Activation and the 20-Minute Rule

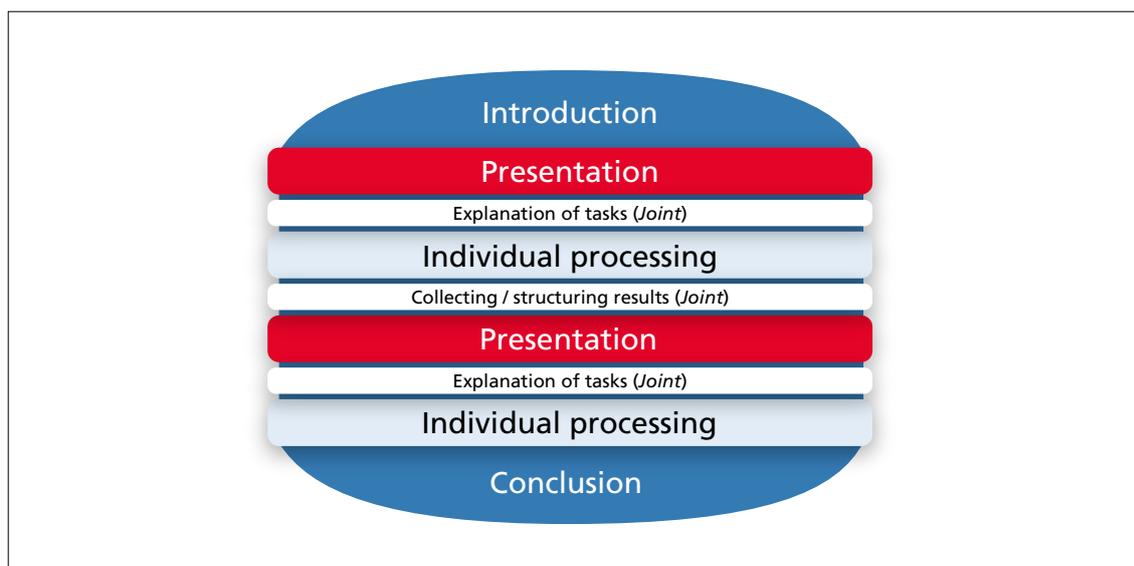
The human working memory has a naturally limited attention span, usually leading to much of the audience becoming restless or tired after some time. The point at which this occurs can of course vary, and may at least partly depend on the quality of a lecture. Decades ago, research led to the *20-minute rule*, which is still widely observed today. German didactics describes this as “*rhythmizing*” – meaning to vary activities within a teaching sequence after an average of twenty minutes.

Did you know the 20-minute rule?  
How many of your teaching sequences exceed 20 minutes?



#### Varying activities using the sandwich principle

The German educator mentioned previously, Wahl (2006), coined a catchy image for the strategy of “*rhythmizing*”, or varying activities: the *sandwich principle* (Figure 19). Just as in a sandwich, where the fillings of your choice are arranged in layers, an ideal lesson consists of alternating phases. After a 20-minute lecture at the latest, learners must be given the opportunity to process what has been presented. Wahl separates the two phases (presentation and individual processing) with linking elements (joints). For example, after an input, the students are given a task for individual processing. This may then be followed by another input, after which the results from the previous processing phase are collected and structured. The effectiveness of the sandwich principle is very well proven theoretically and empirically.



**Figure 19:** Wahl's sandwich principle of varying teaching-learning arrangements (Adapted from Wahl 2006 by K. Herweg)

Of course, if learners are still very engaged with the content after 20 minutes, there is no need to interrupt them. The 20-minute rule applies mainly to monologue situations, including learner presentations, but it is a statistical average that does not rule out the possibility that your students will want to work longer.

### Activating prior knowledge

The important role of learners' prior knowledge has been well documented for decades (see Dochy 1992, Marzano 1998, Dochy et al. 1999). Those who already have background knowledge in a certain subject can anchor new information better and remember it more easily later on. An effective strategy is therefore to activate prior knowledge. Preliminary self-tests (e.g. a questionnaire on prior knowledge status) with instant feedback on the answers (e.g. an online quiz) are a promising measure. Pre-testing has a strong impact on the retention of subsequent learning material (Roediger et al. 2011).

### Activating a large audience

There is a wide range of teaching methods for cognitive activation. Try to keep students as engaged as possible: they learn more when they actively work through the content. This is also possible in the lecture hall. Instead of the usual "Any questions?" at the end (which often goes answered), have small groups discuss a question for three minutes ("buzz groups") or let them work on a small task and then discuss the results in the plenary. Other options include having students come up with advantages and disadvantages of an issue and comparing them afterwards, or asking the learners for their opinions, assumptions, or prior experiences before presenting a particular topic. Such student active breaks work well, even with a large audience.

### Activating smaller groups

Of course, activating smaller groups in seminars is much easier than motivating a larger audience.

- Alternate a 20-minute presentation with an equally long sequence allowing students to process the information.
- Limit working groups to four people.
- Write down assignments based on the learning outcomes; project the assignments to the wall in larger groups.
- Some ideas for assignments are to have students
  - write a short synopsis on the topic
  - set an examination task for other students
  - draw an overview graphic
  - ...

The range of possible activities is almost inexhaustible; the literature and the internet are full of ideas for how to activate learners.

### Strategies for cognitive activation

- Use pre-testing, which has the added effect of reactivating prior knowledge.
- Before your lecture, let your students brainstorm on the question: “What do I already know about the topic?”
- Have the participants formulate questions about the material in advance.
- Follow the 20-minute rule in monologue teaching situations. Consider the sandwich principle, particularly in seminars.
- Use buzz groups, i.e. small-group discussions of simple questions in between two presentations.
- Have learners answer “why?” as often as possible; let them research causes, reasons, and origins in small discussion groups.
- Let them find differences and similarities between new content or between new and old content (sameness analysis).

Cognitive activation is essential for learning gain. Successful learning can only be achieved through active engagement with the content.  
Therefore: **less teaching; more learning.**

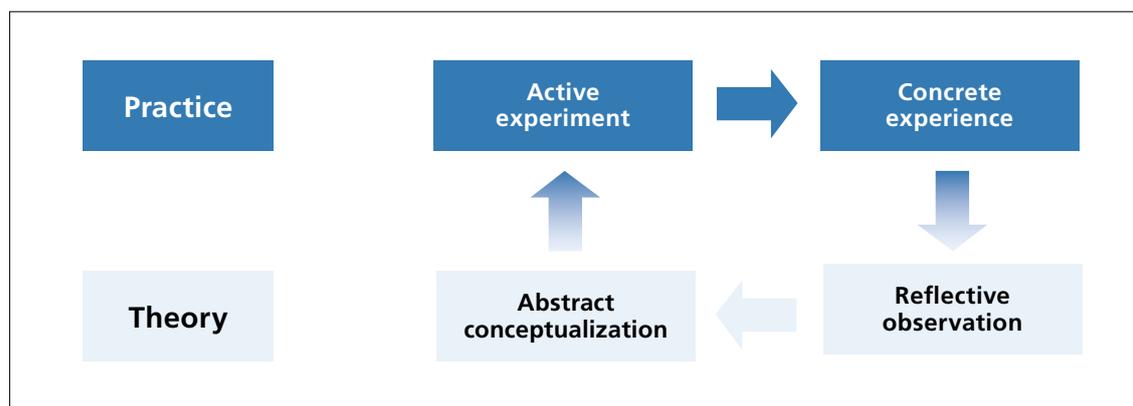


## 4.2 Dramaturgy and Learning Activities

Which script is most likely to get the students to actively engage with learning contents? What short activation methods are suitable to “interrupt” lectures, to enable the audience to process what was said? There is a huge repertoire of methods from which to choose the most appropriate to the specific goals and content.

### Kolb’s “Experiential Learning Theory”

In the 1980s, David A. Kolb developed a pragmatic pedagogical model with the primary aim of linking theory to practice (Kolb 1984). He presents the learning process as a spiral, starting with concrete experience and followed by reflection (Figure 20). With the help of theories, experience is abstracted and then anchored in memory. Knowledge becomes more differentiated through these steps of learning. Refining concepts, models, and theories helps to plan the next steps of action, leading to a next level of the learning cycle. This helps to optimize intuitive action routines and increase professionalism. It also leads away from inert knowledge via action competence to reflective practice.



**Figure 20:** Kolb’s learning cycle (*experiential learning theory*) (Adapted from Kolb 1984 by K. Herweg)

### ICM or Flipped Classroom

The “*Inverted Classroom Model*” (ICM) (Handke and Sperl 2012, Handke et al. 2012), also known as “*Flipped Classroom*”, is more of an approach than a method. Its central feature is the switch between presentation and consolidation (“flip it!”). For example, in a traditional lecture, the lecturer presents the content in the lecture hall, and students work on it before or after, during self-study. In the ICM, by contrast, the presentation is *outsourced* in a digital format (.pdf, .ppt, podcasts, slidecasts, etc.). Students can view it individually

and use it as a basis for completing preparatory assignments. Attendance in the lecture hall is an interactive sequence, where prepared content is addressed, knowledge gaps filled, and contents consolidated or applied to problems. Many different forms and even games are possible, because technology to motivate and stimulate in-person meetings is now very easy to use.

### Components of successful ICM

- **Learning Outcomes:** as with any successful learning arrangement, clear objectives are an essential condition for success, especially if the arrangement includes a lengthy period of self-paced learning. The clearer the objectives, the more individualized the learning path can be.
- **Appropriate Scenario:** Design a script for the entire duration of the course (semester or term plan) based on the learning outcomes. It is essential to decide what should be done in self-study phases and what should be done during lectures.
- **Meaningful Mission:** Participants will most likely neither prepare nor follow up the in-person meetings if the corresponding assignments are not comprehensible, meaningful, specific, and goal-oriented. Assign tasks to process information: simply watching videos or re-reading lecture notes lead to little learning gain.
- **Multimedia Content:** Make use of the fantastic technological opportunities on offer today. It has never been easier to find interesting multimedia content for teaching. Link it to appropriate assignments to enhance existing content with interactive elements.
- **Learning Management System (LMS) or Personal Learning Environments (PLE):** Use the advantages of an LMS such as Moodle or an equivalent electronic platform of your university to manage participants and content. If your institution offers an LMS, there is usually a support team on site to help you get started. In addition, a growing number of providers enable creation of PLEs with links to Google or Facebook accounts, for example.
- **Additional Materials:** An essential element of ICM is the possibility to learn at an individual pace. For internal differentiation it makes sense to provide on the LMS in-depth materials combined with extended assignments for the quick learners.

### Success factors

“Flipping” is an effective strategy for several reasons:

- **Individualization:** Presentation of the information can be adapted to the individual learning pace. If lecturers produce good quality podcasts or slidecasts, students can fast-forward, rewind, pause, and repeat. A further facet of individualization occurs in the classroom, where students fill their knowledge gaps by focusing on their own questions, and sourcing and gathering in-depth information on these themselves.
- **Preparation:** Educational psychology defined the “*Matthew Effect*”. It describes the phenomenon that students with more prior knowledge of a particular subject benefit much more from a corresponding lecture. This empirically well-proven factor is implemented through pre-assignments in the ICM. An additional effect is achieved when the learners work jointly on the content.
- **Feedback:** Instant feedback to learners is another essential factor to significantly promote learning progress in ICM. Live polling in the hall or short discussions in buzz groups make this factor very effective. Comparing ideas about certain facts helps students expand their cognitive structures.
- **Cognitive Activation:** Information is not yet knowledge, and listening is not learning. Having students prepare content in advance and actively engage with it enables them to consolidate it much better during in-person meetings, especially in the presence of the lecturer or expert. Designing a more student-centred classroom teaching experience in which students can apply theories and concepts, significantly supports the development of a subjective feeling of competence among students.
- **Repository:** Educational contents are stored in the LMS and can be used repeatedly and updated without great effort. Corresponding podcasts do not have to be created from scratch every year. When related topics are taught in a team, access to a shared content pool can massively reduce the workload of each team member.

ICM makes teaching more flexible. Input presentations are made available in university online platforms for preparation, allowing for individual learning paths and speed. Tools for creating such presentations are widely available and partly free of charge. Most presentation tools, such as PowerPoint, now have an integrated recording function.

### 4.3 Cooperative Learning

Although many people may remember group work as being unsatisfactory for various reasons, statistical meta-analyses have found cooperative learning to have a considerable impact on learning. Moreover, it strengthens other factors such as self-confidence and social integration, and it reduces the likelihood of dropping out of the course altogether. Cooperative learning is clearly better than its reputation (e.g. see Hattie 2015, Johnson and Johnson 2013, Prince 2004).

#### Think – Pair – Share

Teaching can take place in various social settings, primarily in the following four: *individual work – partner work – group work – plenary*. Not every subject can be covered in all settings. Social setting and choice of teaching strategy are closely related. The “*think – pair – share*” phase model is a simple sequence starting at the individual level, then moving to small groups, and finally to the plenary. This is the basic pattern of many cooperative learning scenarios.

- **think** = individually analyse a topic
- **pair** = exchange in tandem about the results derived at individually
- **share** = present the results of *think* and *pair* to the plenary

**Tip:** Present the working tasks before announcing the altered social setting, otherwise these can easily get lost in the partner search turmoil when preparing for group work.

Research in social psychology has shown that small groups of three to five people can be highly efficient. In a lesson of 45 minutes, the **social setting should be altered** at least once. Your students will welcome the variety. But balance wisely – overdoing it can make the class feel hectic.



#### Avoid token exercises

It is important that group work is not a *token exercise* or used as a stopgap. If students are not used to cooperative learning, start out with shorter sequences before gradually expanding them. Remember that cooperative learning scenarios require transparent scripting, clear assignments, as well as the flexibility to make changes if needed. Let yourself be inspired by the wealth of methods described in the literature on education.

#### Minimize additive tasks

An essential impact factor of successful cooperative learning is *learning through teaching*. Mutual instruction through peers leads to a better anchoring of the learning material in general. But this harbours a risk: if group assignments are easily divided up, members are more likely to complete their parts independently of one other. “Positive interdependence” means that the group task can only be completed if individual team members have to take into account their colleagues’ results to complete their own task. Try to prioritize tasks of this type.

#### Infrastructure for successful cooperative learning

Very mundane factors such as infrastructure are also important. Furniture that cannot be moved and a lack of space strongly hinder cooperative learning. If necessary, request another classroom. But discussions of a few minutes between three people are also possible in the lecture hall, and you can also use technology to expand the scope. For group work to be effective, certain conditions and strategies for effective group work must be taken into account:

- clear assignments and tasks
- defined roles and positive interdependence
- suitable infrastructure
- appropriate group size
- clear process and open learning scenario

In your experience, which learning activities have been most effective in stimulating the development of your intended learning outcomes?



## 4.4 Condensing Content

Varying your learning sequences and adding windows of student activation automatically means reducing your own inputs. But even without this, experience shows that you always have too much material and too little time. This starts with the knowledge advantage you have over the audience and continues with the wealth of information available on the internet. Trying to pack all this into teaching content often leads to the *completeness trap*, i.e. the desire of the knowledgeable to reproduce the “complete” facts and thus overload the learner (Lehner 2013). This is often evidenced by “textual wastelands”, great numbers of slides with text in a small font size. It brings to mind a quote attributed to Einstein: “If you can’t explain it simply, you haven’t understood it well enough”.

### Elementary, Exemplary, Fundamental

In the German didactic field, Wolfgang Klafki is considered the *grand master* of condensing learning content. He has dived into the depths of educational philosophy and, with his approach of categorical education among other things, advocates three essential selection principles for learning content (Klafki 1959):

- **The Elementary:** Choose the essential principles, facts, and concepts.
- **The Exemplary:** Pars pro toto (a part represents the whole) – choose the (proto-) typical, the individual case that represents a wider area of the subject.
- **The Fundamental:** Choose the basic experience and fundamental insights in the perception of the world.

Avoid “PowerPoint tsunamis”. The onion principle (*must – should – could*) helps to reduce your content to the essentials: What are the bare bones; what information is essential for learners to master the given situation (defined by the learning outcomes)? What information is nice-to-have, and can be added if there is more time (which is unlikely)? What information is unnecessary ballast and can be delegated (to self-study or to another course)? If learners work on an assignment instead of just listening to a lecture, they learn considerably more, but they also need more time. This makes it even more important to limit the content to the essentials.

Use your learning outcomes as filters for selecting content:

- Students must be able to cope with situation X (specify formulation of learning outcome)
- What is the minimum information they need to do this (condense content)

In short – **The 4Rs**: The following four steps can be used to select the learning content:

1. **Research:** Find content in relevant and valid sources.
2. **Reflect:** What information does this particular group of learners need to complete the assignments, i.e. to master the situations (as starting points)?
3. **Reduce:** Filter content based on what is exemplary and relevant (*must – should – could*).
4. **Represent:** Decide how to best represent your content: through a direct encounter (field excursion, discussion with practitioners, etc.), through audiovisual aids (videos, photos, sound, etc.), or through text.

**Less content – more processing time.** The onion principle (**must – should – could**) helps to whittle content down to the essentials. Define in the learning outcomes what learners **must** know to master the required situations. Tackle what they **should** and **could** know only if there is enough time.



### Illustration

These days it is easy and effective to illustrate problems, contexts, and processes using video. Real situations can be analysed and assessed in a criterion-oriented way, making the practical relevance easier to establish. Let the learners search for and share videos on content-related issues themselves. You can also enrich videos with interactive tasks and activities. Today, graphic depiction can be further enhanced with interactive tools, e.g. tools for data visualization in statistics programmes. Mixed-reality is also increasingly used for immersion in quasi-realistic situations or for on-site mapping.

### Strategies for condensing and illustrating the material

- Consider Klafki's *three essential selection principles*: With what material can you demonstrate basic principles? What is (proto-) typical? What fundamental insights should grow in the learners, what basic experiences should they make?
- Pictures and graphic illustrations are often worth more than words, but really meaningful illustrations are not easy to find: Search websites like [flaticon.com](http://flaticon.com) or [iconfinder.com](http://iconfinder.com). Even better: Draw yourself! If you can't draw, your attempts will at least elicit general amusement. Both will contribute to a relaxed atmosphere.
- *Must – Should – Could*: Use the onion principle to condense content, using the learning outcomes as a filter.
- Metaphors and analogies are highly effective condensations, if they are securely anchored in the collective prior knowledge.
- Slogans and memorable sentences work especially well when they rhyme ("*Seven, five, three – Rome had to be*"). Let the learners formulate their own slogans and award prizes for the best ones. This is an effective cognitive activation.

### Overview and orientation

Often, learners cannot see the forest for the trees; they get lost in the learning content. Provide an overview: take the learners, figuratively, to the hilltop viewpoint and show them the forest containing the trees they will later examine in detail. In the best case, the learners will leave your lecture aware of the important sub-topics they need to focus on during self-study. Use an Advance Organizer: a graphic overview or mind map of what students are about to learn, using icons or pictures, and placing topics and sub-topics into context.

### Strategies for providing overview and orientation

- When starting your lecture, link to the preceding topic and provide an overview of the upcoming topic.
- Use "Advance Organizers": present a graphic overview of the topics and how they are linked.
- Activate smaller groups with the "Structure Laying Technique": give each team a set of cards containing concepts and ask them to arrange these in a logical structure.
- Link isolated facts to examples, cases, situations, problems, or stories. Always provide a context.
- Remember: Stories are data with a soul!

## 4.5 Supporting Learning Processes

Students learn better when they receive constant feedback on their learning progress. Feedback should go beyond only praise or criticism; it should provide students with differentiated information on their performance. This includes analysing the learning path as well as determining the next, goal-oriented steps. Informative feedback on the correct answers is more beneficial to the learners than focusing on the errors. The well-known psychological principle of "resource orientation" (strengthen the strengths) is more effective than a deficit-oriented culture of emphasizing mistakes. Learning from these mistakes is possible through differentiated feedback. Implement a culture of "productive failure" as a constructive way of dealing with errors. This is an empirically well-tested teaching strategy, as explained in the next paragraph.

### Productive failure

"Learning from mistakes" is an age-old saying which is little questioned as an everyday principle. In reality, though, there is still strong stigma attached to making mistakes. And yet there is enormous learning potential in analysing supposedly erroneous behaviour. Manu Kapur has impressively demonstrated this for academic learning (Kapur 2008, Kapur 2015). Students who have tried and failed to solve complex mathematical problems were able to solve subsequent simpler problems much better than those who solved simpler comparable problems first – provided that the complex problems were in the "zone of proximal development" (Chapter 3.4.2) and the learning process was carefully supported. The challenges of complex problems and the associated attempts to solve them in groups apparently led to the building of important problem-solving skills when the process of failure was analysed meticulously and traceably. Kapur calls this "productive failure". To be productive, failure must be integrated into the teaching–learning scenarios through a constructive feedback process.

### Illusion of knowledge

Communication scientist Elisabeth Noelle-Neumann describes the discrepancy between the subjective experience of being informed and the actual objective information as the “illusion of knowledge” (Noelle-Neumann 1986). This discrepancy is caused, among other things, by not understanding the information and by poor retention. In the course of receiving information and processing it, humans seem to overestimate themselves considerably. According to recent research there is a spillover effect that can, for example, occur after a simple Google search: people who are convinced they are well informed after a simple internet search tend to unconsciously transfer this overconfidence to other questions (or answers). It is therefore not surprising that similar effects occur when learning by listening or watching, and learners eagerly agree when asked whether they have understood a subject – until the moment they have to reproduce what they think they have understood. This is one important reason why formative feedback is such a significant factor in good teaching–learning scenarios.

### Fostering learning through feedback

Feedback has a strong effect on student achievement (Hattie and Timperley 2007, Shute 2008). The focus should not only be on the product, but also on the process and the self-regulation of the learners – ideally not only at the end, but as an accompaniment to the learning process (formative). Assessment criteria are important tools for this. They should be used not only for efficient and fair final (summative) assessments, but also as a helpful framework to compare target and actual performance, for example in interim project briefings. Discrepancies between target and performance can be addressed in discussions between students and teachers. There is great learning potential in this, particularly for the development of metacognitive strategies (Chapter 3.1.2).

### Encouraging self-reporting

Encourage self-reporting and have students monitor their own learning progress. This is an efficient way to see what still needs to be done. The “traffic light method” was often used in lectures before the digital transformation. Ask questions about the material covered, e.g. from the previous week, and give three or four answers linked to different colours (hence “traffic light”). The students answer by holding up the corresponding colour card. As a lecturer, you instantly obtain an overview of the learning status by the “big colour picture” in the room. Then explain the correct answers and give feedback to the students. The overall result will also show you which topic was not yet sufficiently understood.

### Digital sensors

Today, digital tools allow for immediate self-tests in the classroom with integrated feedback. They are easy to carry out, even with many participants. “Live polling” tools are often used as “digital sensors” to detect gaps in students’ knowledge on the spot. Where live polling is anonymous, it lowers the inhibition threshold for participants. In addition, the results of the poll can be shown graphically on the screen and discussed immediately. It is important to note that actual learning gains are triggered primarily by discussion of the results and by evaluating discussions between teachers and students.

### Classroom Assessment Techniques

In smaller seminar groups, “Classroom Assessment Techniques” (CAT) are very popular (Angelo and Cross 1993). In a “One-Minute Paper”, for example, learners have to write a summary of the previous learning sequence in one minute. In “Muddiest Point”, students reflect on which topics are still most unclear to them, writing these on cards with a keyword for each unclear topic. Teachers then quickly evaluate the anonymous cards and know which topics to clarify and discuss with the group. It is in this process – the discussion of the overall results – that the actual learning gains and eureka moments occur.

### Strategies for beneficial feedback

- Keep asking questions about the learning material. Let your students discuss in small groups (buzz groups). Comment on their results and findings, and put these into a broader context.
- For seminar groups (up to about 25 participants) use strategies such as Muddiest Point (the most unclear point), One-Sentence Summary, or One-Minute Paper. Many other methods can be found in the literature (see e.g. *ibid.*).
- Use live polling to ascertain the level of knowledge in large groups by asking specific questions about the material.
- Discussing the results is important! That is where the real potential for learning success lies, as it is through this process that the learners understand why a particular answer is correct or incorrect.
- Use criteria not only for the final (summative) assessment, but also to support the learning process (formative assessment, nominal-actual comparison).

You can best support the learner by providing **regular feedback**.



When and how do you give feedback to support the learning process?



#### 4.6 Guidelines for Designing Learning Scenarios with High Self-Direction

The main goal of “self-directed learning” is the ability to act autonomously. Many forms of self-directed learning are possible, but it can be difficult to make sense of in the literature, as the term is used quite loosely. We therefore provide the following suggestions on how learning scenarios can be designed to make learning processes as fruitful as possible. Some of these scenarios have already been mentioned in Chapter 3 (e.g. Metacognition).

##### **Start with the basics**

Design feasible tasks first. Diagnose prior knowledge and competences in advance and balance them if necessary (with tailor-made assignments or self-assessments). Make sure all learners can operate the learning environment (i.e. the learning management system, or LMS).



##### **Define action-oriented goals**

Start your planning by defining action-oriented goals (module competences, learning outcomes) that you expect the students to reach. Use the goals to derive clear performance expectations and transparent assessment criteria. Communicate the goals in advance: learners need transparent learning outcomes to control their learning process.

##### **Set meaningful missions**

Ensure that the work you set is relevant and useful – and communicate this. Assignments trigger the learning processes that lead to the expected gains in competence. They also build the bridge to the students’ current or future situation in life.

##### **Ensure appropriate workload, comprehensible course structure**

Ensure transparency of procedures and expected workload right from the start. Provide a comprehensible structure for your course. The workload must be appropriate and the process must be based on practicable procedures.

##### **Link self-learning and contact phases**

Structure self-learning phases through milestones. Pick up on and show appreciation of students’ deliveries during contact phases in class.

##### **Implement support measures for learning processes**

Carry out frequent formative assessment as a basis for comprehensive feedback. First self-assessment, then peer feedback, then feedback by an expert. The learning environment must be conducive to implementing the support measures, e.g. during the contact phases.

##### **Cultivate the meta level**

The ability to act autonomously requires permanent reflection. Enhancing metacognitive strategies is an essential part of effective teaching–learning arrangements, particularly in the context of self-directed learning. Address three levels: product, creation process, and self-regulation. Learners must be able to answer three questions at any time: Where am I in the process? What is the goal? What is the next logical step? For this they need individualized support from their teachers.

#### **Facilitate contact between students and teachers**

Effective teaching–learning arrangements must include contact between teachers and learners. Learning in an educational institution is also a socialization process. Students grow into a scientific community whose implicit rules are learned primarily through contact with experienced members. These experienced members – the lecturers – serve as role models. They support learning processes by helping students build their methodological and study skills, and they explain how they themselves deal with the subject matter.

#### **Manage expectations and responsibility**

The allocation of roles must be clear at the start. Teachers must be clear about which topics and contents belong to their area of expertise and responsibility, and for which topics they need to defer to other specialized staff.

#### **Make students aware of rules and regulations**

Important information about the conditions of supervision is compiled in the university's rules and regulations. Learners must be made aware of these. If necessary, you can provide FAQs or further information, instructions, and examples.

#### **Prepare for meetings**

Only coaching meetings that have been adequately prepared for are productive. Preparation must be done by both sides – teachers and students. Have students send their inputs in advance, and set the meeting agenda accordingly.

#### **Activate students' personal resources**

Solution-focused support means also drawing the participants' attention to what they can do, what they have done well so far, and what their strategies for success have been in other, similar situations, etc. Reminding students of skills they already have helps them overcome phases in which they feel blocked. Provide constructive criticism

#### **Provide constructive criticism**

Supporting learning processes will also involve criticism – but not of a destructive kind. It is much easier to trigger change processes through constructive feedback. Constructive criticism is easier for any learner to accept, and therefore more effective.

#### **Be aware of challenges during various phases of coaching**

Long-term coaching processes go through different phases, each with their own typical challenges. It is important for everyone involved to be aware of these challenges. In the first phases, expectations or goals must be made clear, something that may require several meetings.

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## 5 Examples of Transdisciplinary Learning

This chapter describes the following learning events, with specific attention to the integration of SD into transdisciplinary learning:

- Bachelor's course
- Master's course
- Real-World Lab
- PhD Summer School
- Session/block of a course
- Training of Trainers

We present these examples using the **Matrix for action competence-based planning** (Table 4, Chapter 3.5), which is based on the **Guiding Questions** (Quick Guide, Chapter 2), and the **Action Competence Model** (Figure 13 and Table 1, Chapter 3.3.2). Two exceptions are the examples that do not represent courses:

- Example 5.3 (Real-World Lab) represents a **module**, and is thus located at the meso level. We specify the module competences but do not go further into depth, skipping the action competence model in this example.
- Example 5.5 represents a **session/block** within a course; we skip the evaluation at the course level, which does not distinguish individual sessions.

N.B. The descriptions of the examples are much more detailed than would appear in a syllabus. Our aim is to provide precise information that is useful for future course designers.

## 5.1 Development and Environment Field Course – BSc Programme, Institute of Geography, University of Bern

**Lecturers: Stephan Rist, Karl Herweg**

### Brief course description

This field course demonstrates how methods of Physical and Human Geography can be combined in an integrative approach under real-world (farming) conditions, enabling students to build up competences required for both inter- and transdisciplinary research. Which “rough” field methods deliver plausible results of sufficient quality and area coverage? The course begins with a double lecture introducing the fieldwork, which is based on an integrative conceptual framework that was gradually developed over several years. The focus of the course is methodological, with students practicing an array of rough field methods that do not require sophisticated, expensive, and time-consuming laboratory methods (which are taught in separate courses). Rough methods are less accurate, but they include more variables and allow a larger area to be assessed; they are thus more likely to be applied when plausible information is preferred to precise data.

#### What are potential **links** between your discipline and **SD**?

Many geographic **research topics** have a more or less direct link with sustainable development. For example, Physical Geography deals with the use of natural resources and the occurrence of environmental hazards; Human Geography tackles global and local sociocultural and economic disparities, migration, social and armed conflicts, etc. Pathways to sustainable development, however, usually have to consider an integrative approach involving environmental, sociocultural, and economic dimensions (theory). Therefore, Integrative Geography often incorporates inter- and transdisciplinary approaches to research and teaching, in particular when assessing the degree of sustainability of a certain topic – in our example, the sustainability of the agricultural landscape.

Assessing sustainability requires not only consulting secondary information and data from literature. In many instances, it must involve generation of primary data (**research methodology**). In general, sophisticated scientific methods (e.g. laboratory soil analysis, quantitative interview surveys) deliver high-quality data. Such accuracy, however, is expensive, often covers only a small area, and is not always needed in practice: for many pragmatic decisions (**application**), plausible indications can be sufficient.

#### What **fields of work** will the graduates enter?

As professionals, students will be in a position to advise non-specialists on a certain issue. However, not all information may be available in the form of secondary data, so they must be able to collect primary data through field surveys covering all sustainability dimensions (ecological, sociocultural, economic). Often, time and money are limited and expensive scientific methods cannot be applied. Instead, basic interdisciplinary knowledge of social-ecological systems must be available and a variety of “rough” estimation methods must be mastered.

#### What **typical situations** will students have to **master** within these fields of work?

A team is requested to identify starting points for optimizing farm operations. This involves assessing the way the farms are managing their land resources. Primary data must be collected and results summarized in a short report. The team is expected to take a systemic perspective – i.e. to apply systems thinking – to proceed in a solution-oriented way, and to practice a respectful and appreciative exchange with the relevant actors (in this case, farmers). The team must be able to coordinate the preparation of the survey and collect, analyse, and interpret primary data. They need to critically reflect on the methods used and document the results and the assessment in a scientific report. The report should be understandable, also for non-academic actors. Field survey and report writing must be completed within a certain time frame.

#### What **competences** do students need to master these situations?

Students are able to ...

- carry out Physical Geography survey methods
- carry out Human Geography survey methods
- integrate practice- and problem-oriented methods
- assess farms concerning their sustainable land resources management and sustainable livelihood
- plan, conduct, and analyse data collection
- write a scientific report including results and their interpretations

#### What are the **basic organizational conditions** of the course?

The course takes place every spring semester. It comprises about 24 Bachelor's students in their second and third year (broken down into six groups of four students). Some may have attended the elective course *Sustainable land management and regional development*. Instruments are provided by the institute, students are responsible for appropriate clothing, bags, and lunch boxes; to collect their data, it is expected that students attend the field site daily from 8 a.m. to 6 p.m. in all weather conditions. Students usually appreciate fieldwork because most courses take place in the classroom.

<b>Action Competence Model</b>	<b>Academic Knowledge about ...</b>	<b>Professional Skills mastering ...</b>	<b>Critical Awareness (attitude / values) regarding ...</b>	<b>Constructive Alignment 1</b> <b>What are the intended learning outcomes?</b> <i>Students are able to ...</i>
<b>Professional Competence</b> <i>(handling the subject)</i>	<ul style="list-style-type: none"> <li>• sustainable land management and regional development</li> <li>• sustainable livelihood approach</li> <li>• mapping surveys</li> <li>• diagnosis by spade and auger (rough methods of soil analysis)</li> <li>• interview methods</li> <li>• error estimation</li> <li>• structure of scientific reporting</li> </ul>	<ul style="list-style-type: none"> <li>• mapping, determining various parameters of topography, land use, vegetation, soil surface, and soil (e.g. slope shape/gradient, vegetation cover, erosion features)</li> <li>• determining selected soil parameters (e.g. texture, structure, rooting, infiltration, density, aggregate stability, org. matter, pH) through spade and auger diagnosis</li> <li>• planning, conducting, analysing and interpreting interviews</li> <li>• writing target-group-specific texts</li> </ul>	<ul style="list-style-type: none"> <li>• errors/accuracy while applying rough methods</li> <li>• validity of methods</li> <li>• potentials and limitations of methods</li> </ul>	<ul style="list-style-type: none"> <li>• map relevant spatial parameters</li> <li>• select relevant positions for data collection</li> <li>• analyse soil profiles using rough methods</li> <li>• determine sociocultural and economic parameters by interview</li> <li>• assess the quality of rough field survey methods</li> <li>• determine different actor perspectives on land management and livelihood</li> <li>• interpret results properly</li> <li>• assess the state of natural resources and livelihoods in view of their sustainability</li> <li>• illustrate spatial connections of land management</li> <li>• determine connections of ecological, sociocultural, and economic factors of influence on sustainability of farms</li> </ul>
<b>Social Competence</b> <i>(handling others)</i>	<ul style="list-style-type: none"> <li>• rules and recommendations to conduct interviews</li> <li>• active listening</li> <li>• motivating chairmanship / negotiation</li> </ul>	<ul style="list-style-type: none"> <li>• structuring a conversation</li> <li>• techniques of active listening</li> <li>• pragmatic division of team tasks</li> <li>• motivational interviewing</li> </ul>	<ul style="list-style-type: none"> <li>• advantages and disadvantages of teamwork</li> <li>• mutual respect and hospitality of interviewers and interviewees</li> <li>• mutual support in the team</li> </ul>	<ul style="list-style-type: none"> <li>• plan semi-structured Interviews on the basis of the Sustainable Livelihood Approach (SLA)</li> <li>• conduct respectful and productive conversation with farmers</li> <li>• structure, analyse and interpret information gathered through interviews</li> <li>• illustrate different livelihoods on the basis of SLA</li> <li>• exchange results and write a group report within the given time and length</li> </ul>
<b>Personal Competence</b> <i>(handling oneself)</i>	<ul style="list-style-type: none"> <li>• individual socialization process</li> <li>• expectations of, and conflicts between, different roles</li> </ul>	<ul style="list-style-type: none"> <li>• planning and time management</li> <li>• self-organization of the team during fieldwork</li> </ul>	<ul style="list-style-type: none"> <li>• personal learning process based on practical experience</li> <li>• stamina</li> <li>• positive idea of humans</li> <li>• expectation of self-efficacy</li> <li>• personal relationship with agriculture</li> <li>• perception of one's own role</li> </ul>	<ul style="list-style-type: none"> <li>• formulate personal field experience (e.g. transformative moments)</li> <li>• finish a task, also under harsh and uncomfortable conditions</li> <li>• develop alternative procedures, if measurements cannot be carried out as planned</li> <li>• improvise</li> </ul>

### Constructive Alignment 2

What **learning activities** will help students to achieve these learning outcomes? What learning environments and teaching–learning arrangements support creating spaces for transformative moments?

Since this course is not compulsory, participating students bring with them diverse previous knowledge. The course therefore starts with a **double lecture** (90 mins) that provides an introduction to Swiss agriculture, sustainable land management, and general methodological questions related to integrative/interdisciplinary research approaches.

As **homework** after the introduction, students familiarize themselves with basic literature and documents (agriculture, methodological field manual) and submit their interview questions for feedback prior to the fieldwork.

For most students, this is their first time carrying out a **field survey**. Repeated application of survey methods would require a block course structure, i.e. five consecutive days including four days of fieldwork and one day of supervising the start of data analysis. Fieldwork cannot be simulated in online teaching–learning arrangements, but introductory and final elements can.

### Constructive Alignment 3

How will you assess whether students have achieved the learning outcomes? What **assessment formats** help to determine incremental achievement of the intended competences?

Students receive **written feedback** on their interview questions prior to the survey.

During the entire field survey, there is **intensive supervision** while applying Physical Geography methods (mapping, spade, auger) and Human Geography methods (conducting and analysing the interview).

A grade will be given for submission of a **final group report**, including detailed description of the methods, data, interpretations, and critical evaluation of all methods, as well as a synthesis (comparative assessment of the sustainability of two farms). The groups receive written feedback on their reports.

How and when will you **evaluate the effectiveness** of the teaching–learning arrangements and teaching strategies? What **transformative moments** appeared during the course?

#### Evaluation

Every year the course is evaluated either through the official evaluation format of the University of Bern, or – for more informal feedback between official evaluation years – through our own, shorter evaluation format. This is usually carried out at the end of the course. At this time, however, students will not yet have fully *digested* their field experience. Therefore, we request that they include a short reflection on what they have learned as part of the final group report, a few weeks after the end of the course. This feedback allows us to gain much better insights into the effectiveness of the course, particularly in view of “transformative moments”.

#### Transformative moments

Whether or not transformative learning takes place depends on a number of factors, such as the personal disposition of a student, his/her social environment, and external triggers. However, the mere fact of being in the field and out of the lecture hall offers opportunities for transformative moments to arise. Many students have expressed their appreciation that this field course made them think differently, even if only gradually. The following summary is based on students’ course evaluations, on observations of lecturers, and on feedback by farmers.

- “*At last, something practical*” ...! Most courses are rather theoretical, despite the fact that Geography offers many links to practice. A practical course opens opportunities and insights – for many students for the first time, e.g. to contest theory through application, to better understand by looking at it from a different perspective, and thus to deepen their knowledge about social-ecological systems.
- Analysing soils in the field or interviewing farmers in their working context, for example, involves learning with many senses (seeing, smelling, feeling, tasting). This allows students to understand sustainability through various perspectives, provoking questions, different lines of thought, and associations. Complex social-ecological systems can literally be *grasped*. This makes it hard not to feel enthusiastic about at least something!
- In the media, farmers are often blamed for polluting the environment. However, talking to some of them personally and meeting them on the farm helps us understand that they are not carelessly handling the environment, but that their actions are often limited by political and economic conditions. This experience helps students appreciate and respect farmers’ hard life, their hospitality, and their experience. Vice versa, farmers acknowledge that “*students find their way out of the classroom into our reality before disappearing into offices that impose more regulations on us*”. They experience that they can make useful contributions to society and the environment, and gain an increasing feeling of self-efficacy.
- Applying methods also means learning how data quality can vary due to measurement errors (given that data is often taken from secondary sources without knowing about or reflecting on the quality). Students learn that decisions taken on the basis of inaccurate data can affect farmers’ lives. We observe that repeated application increases self-confidence and leads to students assuming responsibility for their own work.
- A field course requires a good mix of independent learning-by-doing and supervision. Joint fieldwork is also a social event; it builds confidence and helps reduce the hierarchical distance between students and lecturers. Students report

regularly about a pleasant working atmosphere, a growing feeling of cohesion in the team, and meeting supervisors on a more equal footing. This makes it easier for many to ask questions. They appreciate talks about the subject, but also informal discussions about other issues, and learning from the experience of supervisors and farmers.

- Students experience that reality does not always follow classroom theories and strategies. Mistakes, repeated application, and gradual familiarization with instruments and methods are part of that reality. Such experiential learning involves challenges in applying methods, requiring students to improvise, develop routines, struggle with the weather, deal with errors and accuracy, and the like. It gives students a better *feel* for methods, where and when they can be applied and where not. At the same time, it provides an opportunity to deepen, through testing in practice, previous theoretical knowledge on sustainable land management. And finally, yet importantly, the course offers many opportunities to build or expand social and personal competences that will be helpful during the Bachelor's or Master's thesis at a later stage.
- And finally, a student's reflection on the 2021 field course: *"I must honestly admit that I was not amused on the first day to see 5 cm of freshly fallen snow on the ground. My motivation decreased considerably. Retrospectively, however, I must say that it was a very useful and pleasant week for me. ... It became clear to me how important farmers are for our society, and with how much passion they do their job. I was really impressed by the interview with the farmer talking about sustainability. Since completing this course, I have caught myself several times while shopping thinking about what food label I should support. I also check more carefully where the food in the shop comes from, in order to support more local products."*

## 5.2 Applied Integrative Geography – MSc Programme, Institute of Geography, University of Bern

**Lecturers: Stephan Rist, Karl Herweg, Christian Pohl**

### Brief course description

Topics considered in this course include natural resource management, sustainable agriculture, food security, free trade agreements, etc. that influence agriculture in Switzerland. This course simulates the first phase of td research, i.e. selecting a research topic and negotiating research questions with societal actors. After becoming familiar with the td research approach and the course topic, students conduct interviews with selected societal actors. The aim is to design a td research project to assist the actors in implementing sustainable solutions; it is not the aim to solve the problems on behalf of the actors. At the end of the course, the projects are presented to the actors and discussed with them. Students also prepare a final report summarizing the topic and the td procedure, including a critical reflection of the procedure, comments by the actors, and their own learning process.

#### What are potential **links** between your discipline and **SD**?

In order to address and help solve sustainability problems, Geographers often work in scientific teams and with societal actors. There is a huge variety of potential **(research) topics**, which may be identified by researchers, or society, or jointly. Work on effective sustainable solution pathways in complex problem settings involves different theoretical approaches **(theories)**, such as systems theory, development theories, theories of action, etc. The complexity of the problem setting calls for an interdisciplinary (td) research approach; the solution orientation requires a transdisciplinary (td) research approach, which automatically aims at **application**. Both id and td research involve specific td methodologies and tools that mostly need further development during application.

#### What **fields of work** will the graduates enter?

Working in inter- and transdisciplinary teams on different tasks, such as problem analysis, development of solutions, etc.

#### What **typical situations** will students have to **master** within these fields of work?

In their professional working lives, students will have to be familiar with a td approach; familiarize themselves quickly with different topics; communicate with team members and societal actors; and present their work orally and in writing.

#### What **competences** do students need to master these situations?

Students are able to ...

- carry out a transdisciplinary research procedure as a team
- integrate various tools and methods of a td procedure
- identify sustainability problem settings
- plan a research project that supports societal actors in solving the problem
- present and discuss a project proposal
- write a scientific report including a reflection on the td procedure and what was learned in the course

#### What are the **basic organizational conditions** of the course?

The course takes place during the autumn semester and comprises about 24 Master's students in their fourth and fifth year, broken down into four groups of six students. The course is held on Friday afternoons from 1 p.m. to 5 p.m. Most sessions are group work, i.e. attendance is compulsory. We require a lot of flexibility of the students; they need to be willing and able to organize personal and group work themselves.

<b>Action Competence Model</b>	<b>Academic Knowledge about ...</b>	<b>Professional Skills mastering ...</b>	<b>Critical Awareness (attitude / values) regarding ...</b>	<b>Constructive Alignment 1</b> <b>What are the intended learning outcomes?</b> <i>Students are able to ...</i>
<b>Professional Competence</b> <i>(handling the subject)</i>	<ul style="list-style-type: none"> <li>• sustainable agriculture and food security</li> <li>• sustainable livelihood approach</li> <li>• value-added chains</li> <li>• interview methods</li> <li>• structure of scientific reporting</li> </ul>	<ul style="list-style-type: none"> <li>• procedures of the td research approach</li> <li>• literature search</li> <li>• presenting to peers and societal actors</li> </ul>	<ul style="list-style-type: none"> <li>• potentials and limitations of methods</li> </ul>	<ul style="list-style-type: none"> <li>• summarize important schools of thought in inter- and transdisciplinarity and their links to Integrative Geography</li> <li>• summarize a given problem context in the field of sustainable agriculture and food security</li> <li>• determine environmental, sociocultural, and economic factors of influence on the given context by interview</li> <li>• design a td research project, including a conceptual framework, research questions, and integrative methodology, based on independent literature studies of thematic, theoretical, and conceptual foundations, interviews with local actors, and intense group work.</li> <li>• assess the relevance of the proposed project to the region and its actors</li> </ul>
<b>Social Competence</b> <i>(handling others)</i>	<ul style="list-style-type: none"> <li>• rules and recommendations for conducting interviews</li> <li>• active listening</li> <li>• motivating chairmanship / negotiation</li> </ul>	<ul style="list-style-type: none"> <li>• structuring a conversation</li> <li>• techniques of active listening</li> <li>• pragmatic division of team tasks</li> <li>• motivational interviewing</li> </ul>	<ul style="list-style-type: none"> <li>• advantages and disadvantages of teamwork</li> <li>• mutual respect and hospitality of interviewers and interviewees</li> <li>• mutual support in the team</li> </ul>	<ul style="list-style-type: none"> <li>• plan semi-structured interviews</li> <li>• conduct respectful and productive conversation with societal actors</li> <li>• structure, analyse, and interpret information gathered through interviews</li> <li>• communicate and illustrate the project in an understandable and attractive way with peers and with societal actors</li> <li>• moderate a critical discussion/feedback workshop with societal actors</li> <li>• write a group report within the given time and length</li> </ul>
<b>Personal Competence</b> <i>(handling oneself)</i>	<ul style="list-style-type: none"> <li>• expectations of, and conflicts between, different roles</li> </ul>	<ul style="list-style-type: none"> <li>• planning and time management</li> <li>• self-organization of the team during fieldwork</li> </ul>	<ul style="list-style-type: none"> <li>• flexibility and frustration tolerance</li> <li>• expectation of self-efficacy</li> <li>• perception of one's role</li> <li>• reflection on one's learning process</li> </ul>	<ul style="list-style-type: none"> <li>• adapt to unplanned changes during a self-controlled work process (limited inputs by lecturers, group processes)</li> <li>• formulate personal experience (e.g. transformative moments)</li> </ul>

### Constructive Alignment 2

What **learning activities** will help students to achieve these learning outcomes? What learning environments and teaching–learning arrangements support creating spaces for transformative moments?

**Seminar sessions:** First, the students learn about different schools of transdisciplinary research to develop a theoretical background. They then familiarize themselves – usually, in very little time – with the course topic (e.g. tree trade agreement), to be able to interview the different actors involved. This is done in self-study rather than through lectures, so the students read selected documents and papers, and they summarize and present different facets of the topic to their seminar group.

**Fieldwork:** With the background gained during their seminar sessions, students work in groups to prepare interviews of selected societal actors. Lecturers comment on the interview questions and accompany the students conducting the interviews. For organizational reasons, the course organizers select the actors beforehand, ensuring that they have the actors’ consent to be interviewed and later to comment on and discuss students’ research proposals. During the interview, each group is accompanied by a lecturer.

**Exercise:** The students control the main part of the course and are responsible for analysing the interviews, identifying the problems, analysing actor-power relations, developing a vision of a solution (“rich picture”), specifying a research project, and preparing a presentation. The role of the lecturers is to provide coaching when needed; in addition, they gradually introduce the relevant tools of the td procedure. During this part, the students determine their topic and their own speed of progress, including making mistakes and correcting them. The only deadline is the session before the final presentation to societal actors.

**Presentation:** At the end of the semester, the groups present their work and discuss potentials and limitations of their study with the actors they interviewed initially.

### Constructive Alignment 3

How will you assess whether students have achieved the learning outcomes? What **assessment formats** help to determine incremental achievement of the intended competences?

During the seminar, fieldwork, and exercise, students receive continuous feedback on their work and presentations. Grades are given for the final (public) presentation including the discussion with societal actors (50%) and the final (scientific) report (50%).

How and when will you **evaluate the effectiveness** of the teaching–learning arrangements and teaching strategies? What **transformative moments** appeared during the course?

#### Evaluation

The course is evaluated through the official university evaluation format and through an additional evaluation of our own. Another element of evaluation is that students include a short reflection on what they learned as part of the final group report, which they submit around 1.5 months after the course. This gives students the chance to reflect thoroughly on their learning progress, particularly in view of “transformative moments”.

#### Transformative moments

- In our observation, expectations of students have changed in recent years. Probably accustomed to detailed and precise instructions for homework, exercises, and exams in high school, they expect the same at university level. No doubt, clarity and transparency are success factors of learning processes; however, later in professional life students will have to learn the hard way to master situations where there is no detailed manual, but only a desired output and a number of td tools to get there.
- In this course, we purposely put students in the situation where there is no “best” way of designing a project, but that they do so through trial and error. The onus is on the students to familiarize themselves with their topics. Simultaneously, instructors are no longer the “specialists”, and they gradually transfer responsibility and decision-making to the students. Many students initially have problems with working this way; they feel insecure and seek frequent confirmation that they are on the right track. The main task of the lecturer is to coach and advise students on thorough preparation of the presentations they will hold for an external audience.
- This method of lecturers staying in the background and giving students the opportunity to be more actively involved has always been successful so far. The quality of student presentations is very high, as they realize the importance of creating and holding a good presentation for critical practitioners. Students feel at home in the chosen topic as they have worked on it so intensively, even if it was completely new at the start of the course. Their ways of presenting publicly are very creative and diverse, and practitioners engage in discussions immediately, without any embarrassing moments of silence after asking the audience for a reaction!
- We found that when asked to evaluate the course immediately after it ends, most students complain about limited instructions throughout the course. However, asked to provide their written feedback more than a month later (giving them time to *digest* the course), we receive astonishing feedback on what they feel they have learned. Most of it refers to an increased ability to work productively in teams, when moments of frustrating stagnation have been overcome with new ideas and good results.

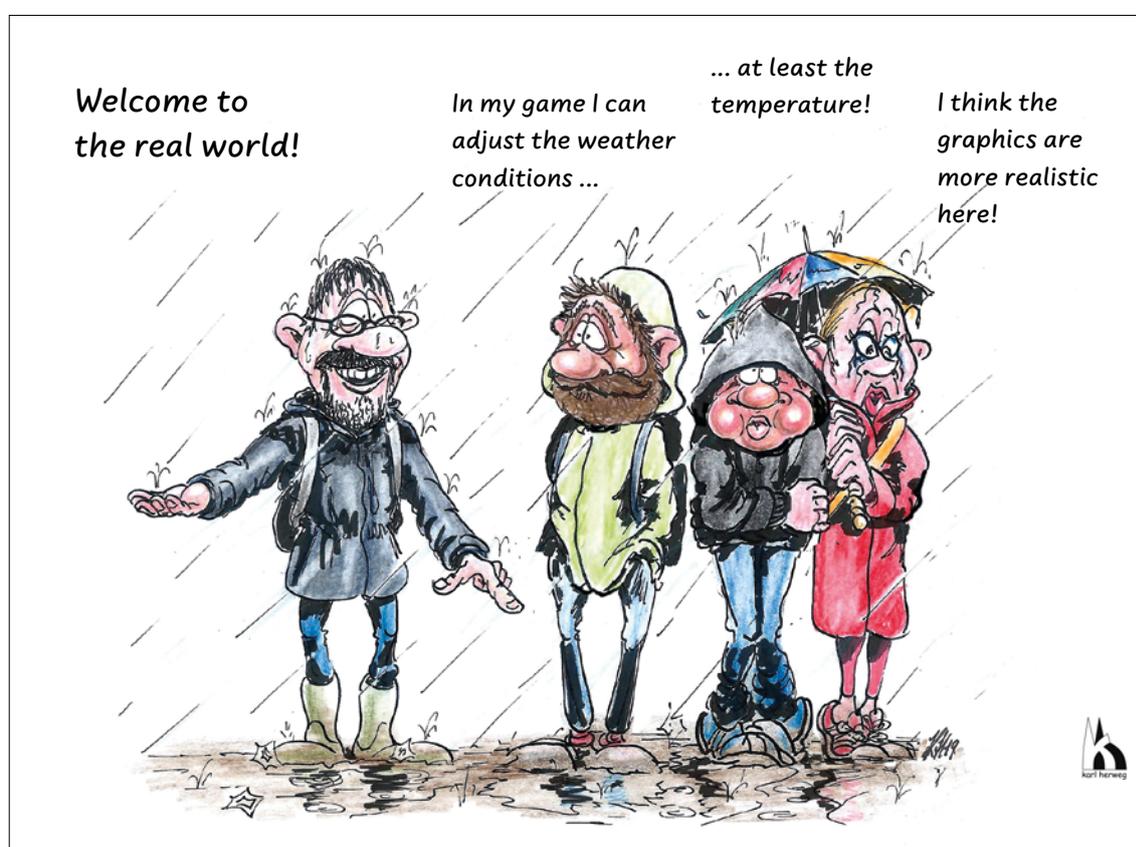
For many students it is the first time they have received encouraging feedback from practitioners, and this strengthens their feeling of self-efficacy (“*my work is useful for society*”). The groups really feel proud of their accomplishments. After the official discussion, we jointly organize an Apéro, with each student contributing a dish of something (usually) homemade. In this informal setting, the floor is then open for unofficial discussion and exchange. We have some actors who participate every year, telling students that they always take home something interesting to think about further.

### 5.3 Real-World Laboratory (module) – BSc, MSc, and PhD Programme, Institute of Geography, University of Bern

**Lecturers: Stephan Rist, Karl Herweg**

#### **Brief description**

Ideally, transdisciplinary (td) research implies long-term cooperation – knowledge co-production – of science and practice, which is strongly reliant on long-term financing. In our example of the “Real-World Lab” (Renn 2018; Rogga et al. 2018) in Frienisberg region, canton of Bern, Switzerland, funding was available only during two separated periods of 3–4 years, and it was used mainly for PhD studies. Since knowledge co-production is social learning, there is a strong potential for integrating aspects of a study programme into the research. We were thus able to bridge the time slots between the funded periods with fieldwork related to various aspects of Bachelor’s and Master’s courses (e.g. thesis research). This has allowed us to maintain continuous cooperation and knowledge co-production for more than 15 years. In addition to fieldwork for Bachelor’s or Master’s theses, three courses were held every year, collectively forming a module on sustainable land management and sustainable rural livelihoods: a BSc-level lecture with exercises (without fieldwork), a BSc field course (example 5.1), and a Master’s exercise with fieldwork (example 5.2).



**What are potential links between your discipline and SD?**

Understanding and transforming complex society–environment interrelationships, i.e. social-ecological systems, is a core contribution of science in SD. A research approach proven to make significant contributions to SD is transdisciplinarity (td), which is based on the co-production of knowledge (Chapter 1.3) of an interdisciplinary team of scientists (students) and various groups of practitioners.

**What fields of work will the graduates enter?**

Researchers involved in transdisciplinary research for SD need to be able to work in interdisciplinary teams with other actors. A field of work that is closely linked with SD is sustainable agriculture, which involves all sustainability dimensions (ecological, sociocultural, and economic).

**What typical situations will students have to master within these fields of work?**

Td research in the field of agriculture is diverse. It may involve the need to rapidly familiarize oneself with information available on a specific problem (scientific papers, grey literature, narratives). A comprehensive collection of additional primary data may be necessary. Solutions must be found which are ecologically sound, technically feasible, socioculturally acceptable, and economically viable. And this all takes place in an interdisciplinary team of scientists working closely with diverse groups of practitioners.

**What competences do students need to master these situations?**

Students are able to ...

- analyse problems holistically
- collect all necessary primary and secondary data and information
- develop potential solutions jointly
- assess potential effects and side-effects of these solutions
- monitor the actual effect of implemented solutions
- communicate adequately with other scientific disciplines as well as with other actors

**What are the basic organizational conditions of the course?**

None of the three courses are compulsory. Although a number of interested students attend the whole “module”, many others enter one of the courses without prior knowledge of the field of study or topic. This is compensated by a short introduction at the beginning of each course. The fieldwork site is located about 20 km north of Bern, easily accessible within 30 minutes by public transport. Field visits are suitable either in a course lasting the whole morning or afternoon, or block courses. No accommodation is needed, and students are responsible for organizing their own food and drinks. We regularly announce topics for Bachelor's and Master's theses, but students make their selections based on their interests. This means that it is impossible to schedule set topics. Nonetheless, there is always a sufficient number of farmers who appreciate the continuous exchange with students and supervisors, receiving us for interviews and providing their fields for spade tests, drillings, and mapping.

**What learning environments and teaching–learning arrangements support creating spaces for transformative moments?**

Each course is composed of a combination of teaching formats such as lectures, seminars, exercises, and practice (except the lecture). Thus, there is always a mixture of theory and practice, giving students the opportunity to test their theoretical knowledge. Since the core of td research is cooperation (knowledge co-production) involving science and practice, the encounter with practitioners both in the field and in the lecture hall is essential. Building social and personal competence takes place practically, before it is debated and reflected on.

**How will you assess whether students have achieved the learning outcomes? What assessment formats help to determine incremental achievement of the intended competences?**

The only written exam that tests “knowledge and understanding” is the first part (a lecture) of the first course (out of three courses). All other subsequent learning outcomes are assessed through intensely supervised classroom and field exercises coupled with feedback on the learning progress. The final assessment of all courses involves producing a poster, and/or a presentation, and/or a report. These forms reveal the students' knowledge implicitly, as well as their ability to transform this knowledge to a specific context. In addition, the assessment makes students critically reflect and evaluate the results of their work, improve their communication skills, and formulate their lessons learned.

### What **transformative moments** occurred in the Real-World Lab?

- The long duration of the real-world lab was possible only because of mutual respect and confidence. Farmers are not expecting scientific experiments to present them with tailor-made solutions: some research results might no longer be up to date by the time they are published. Farmers mainly cooperate because, first, they appreciate that students show interest in and value their work. Second, the farmers consider their cooperation a meaningful contribution towards educating the younger generation. And third, they appreciate the diversity of topics related to farming, which emerge in the course of our field visits and work.
- Students generally appreciate practical work and encounters with practitioners, as it demonstrates that this type of work is useful and relevant to society, which increases their expectations of self-efficacy. A partial role reversal takes place, as students largely select topics and apply scientific methods of their own choosing, while lecturers gradually withdraw and become coaches. As a result, students begin – and continue to – assume more responsibility for the outcomes of their work.
- Students' reflections on their learning progress reveals quite a heterogeneous picture of what we could call transformative learning. Some decide to do their Bachelor's or Master's thesis in this field of study and/or on related topics, but for varying reasons: some are fascinated by the topic of sustainable land management; some become enthusiastic about practical work with people; and some are attracted by the desire to engage in biophysical measurements and mapping outdoors. Many students report they are inspired by the quality of a product achieved by a team in a good working atmosphere. This can be an opportunity to receive motivating reactions about their own strengths – i.e. strong intrapersonal resources that they already have – such as personal time management, clear communication, illustration or writing skills, sociable performance, and many more.

Experience shows that transformative moments depend on a number of factors. Teamwork can be difficult where levels of motivation among students vary greatly. Fortunately, this has been the exception in our course so far, but poorly motivated students can disrupt a whole team. Bad weather may be a factor of disturbance in the short term, but at the end, it can also give students a feeling of euphoria at having mastered a difficult situation. For these reasons, we recommend not evaluating the course just after it ends, but rather giving students some time to think about what they have learned and having them formulate it a month or so later, for example, in a chapter of reflection in the final report.

## 5.4 International Graduate School (IGS) North-South – PhD Summer School (advanced certificate), Universities of Bern, Basel, Zurich, and Lausanne

**Lecturers: various**

### Brief course description

The IGS North-South PhD Summer School takes place annually in different parts of the world. An intercultural learning event, it enables exchange among an interdisciplinary group of PhD candidates. The 10–14-day event offers students the opportunity to learn and experience (abridged forms of) all phases of td research. Participants attend seminars on concepts and methodologies of td, after which they put their knowledge and skills into action in an exploratory survey exercise in a local context. The goal of the exercise is to design a transdisciplinary research strategy on specific issues of development and global change in a context of sustainable regional development in a local setting. During the intense fieldwork, the scholars also meet with non-academic stakeholders. Coaches are on hand to guide the students in this transformative approach. Fieldwork usually lasts three days, plus preparation and analysis, presentation, and discussion of results.

#### What are potential **links** between all disciplines represented in the course and **SD**?

The course brings together students from different disciplines and different cultural backgrounds. As SD is the main “topic” of the course, the challenge for all participants is to find **thematic links** between their specific background and mindset, with SD. Having direct contact with non-academic stakeholders in the exploratory survey exercise, participants make individual contributions to the overall **methodological package**. In a field exercise, students experience what interdisciplinary cooperation really means, through the complex task of developing their own research proposal in a group of team members with knowledge in different disciplines. They also experience what it means to work in a transdisciplinary way, by complementing their disciplinary knowledge with knowledge gained from local stakeholders “on the ground”. The ultimate aim of td research in SD is to find sustainable solutions that are then implemented by non-academic stakeholders. The ultimate aim of this course, therefore, is to formulate a project proposal that can assist local actors to strive for more sustainability.

#### What **fields of work** will the graduates enter?

Many PhD graduates stay in the academic world and also become teachers. Some alumni become policymakers themselves, assuming key positions in government. Others yet join the private sector.

Whatever their profession, the graduates will likely end up addressing a diversity of problems in their future work. The solutions they find will affect different actors in different ways: the effects may be positive or negative; or there may be unexpected side-effects. Also, the effects will concern different sustainability dimensions (environment, society, economy – and additionally, possibly culture). It will therefore be important to be able to cooperate in inter- and transdisciplinary teams on various tasks, analysing problems or developing solutions.

#### What **typical situations** will students have to **master** within these fields of work?

As professionals, students may encounter very specific and possibly unfamiliar local contexts. They must be open to diverse local perspectives and needs. This means that the challenge they face is to manage knowledge co-production under real-life conditions, as opposed to in a controlled office situation. Learning and really experiencing what a td-approach may look and feel like will help students in their further careers cooperate with different actors and diverse topics and communicate beyond disciplinary and cultural borders. Allowing and handling emotions may be one of their greatest challenges later in professional life.

#### What **competences** do students need to master these situations?

Students are able to ...

- apply all necessary steps of the td procedure, based on a jointly developed td concept
- include different points of view and handle different opinions among group members from different disciplinary and/or cultural backgrounds
- identify sustainability problems of a very specific local setting in a participatory way
- consider environmental, sociocultural, and economic aspects in problem analysis as well as identifying potential solution pathways
- design solutions that assist local actors, not solve problems on behalf of them
- present and discuss a project proposal

#### What are the **basic organizational conditions** of the course?

This 10–14-day course takes place once a year in different parts of the world. It is attended by about 30 PhD candidates attending university either in Switzerland or internationally. We expect participants to be curious and open to other perspectives while they interact in an inter- and transdisciplinary and intercultural setting.

<b>Action Competence Model</b>	<b>Academic Knowledge knowing ...</b>	<b>Professional Skills mastering ...</b>	<b>Attitude/Values Critical consciousness regarding ...</b>	<b>Constructive Alignment 1</b> <b>What are the intended learning outcomes?</b> <i>Students are able to ...</i>
<b>Professional Competence</b> <i>(handling the subject)</i>	<ul style="list-style-type: none"> <li>• appropriate interview methods for “ad-hoc” interviews with local stakeholders</li> <li>• td approaches and different thematic theories</li> </ul>	<ul style="list-style-type: none"> <li>• self-organized project planning and setting topical priorities</li> <li>• present findings from the exploratory field survey to peers and societal actors</li> <li>• develop a new research proposal structure adapted to local needs</li> </ul>	<ul style="list-style-type: none"> <li>• awareness of different cultural and disciplinary backgrounds that form different understandings and worldviews</li> </ul>	<ul style="list-style-type: none"> <li>• navigate an intercultural, interdisciplinary, and transdisciplinary setting of the exploratory case study</li> <li>• integrate selected theoretical and conceptual foundations of inter- and transdisciplinary research and broad features of SD in the context of UN initiatives</li> <li>• incorporate the main features, concepts, potentials, and limitations of local ways of thinking about and acting upon key issues of sustainable development</li> <li>• adapt own research methodologies to the given context</li> </ul>
<b>Social Competence</b> <i>(handling others)</i>	<ul style="list-style-type: none"> <li>• the local background by actively listening to their local student peers and resource persons</li> <li>• different disciplinary views on the topic by co-working with student peers and co-creating new knowledge</li> <li>• interview rules and recommendations</li> <li>• chairmanship / negotiation</li> </ul>	<ul style="list-style-type: none"> <li>• pragmatic division of tasks considering know-how and interests of all group members</li> <li>• listening to and respecting other opinions</li> <li>• structuring a conversation</li> <li>• techniques of active listening to peer students and local actors</li> <li>• addressing (culturally) sensitive issues diplomatically</li> </ul>	<ul style="list-style-type: none"> <li>• encounters with local stakeholders in an ethically reflected way</li> <li>• advantages and disadvantages of teamwork</li> <li>• mutual respect and hospitality of interviewers and interviewees</li> <li>• motivation and mutual support in the team</li> </ul>	<ul style="list-style-type: none"> <li>• communicate with peers and non-academic actors and present their position and findings in an effective and understandable manner</li> <li>• integrate their thematic knowledge and methodological know-how in inter- and transdisciplinary teams</li> <li>• reflect on their own role as a researcher by interacting with student peers and local stakeholders</li> <li>• use and experience the participatory spaces for learning with peers</li> </ul>
<b>Personal Competence</b> <i>(handling oneself)</i>	<ul style="list-style-type: none"> <li>• the personal discovery of incomplete knowledge on a certain topic by listening to and understanding student peers</li> </ul>	<ul style="list-style-type: none"> <li>• testing things out, reflecting on and practicing different roles</li> <li>• motivating self-organizing the team during fieldwork</li> <li>• reflecting on one’s own learning process</li> </ul>	<ul style="list-style-type: none"> <li>• reflecting on the power position as a researcher in the field in a new and maybe foreign environment</li> <li>• own mindsets and worldviews</li> <li>• own flexibility and frustration tolerance</li> <li>• own expectation of self-efficacy</li> </ul>	<ul style="list-style-type: none"> <li>• reflect on their mindsets and possibly adopt an open attitude towards the new experiences made in the group and on the local ground</li> <li>• use the safe space of learning to open up and be receptive to experiencing transformative learning moments</li> <li>• handle possible disruptive moments which can confuse existing mindsets and maybe lead to new insights linked with changes in practice (especially scientific practice) and changes in attitude with regard to identities</li> </ul>

### Constructive Alignment 2

What **learning activities** will help students to achieve these learning outcomes? What learning environments and teaching–learning arrangements support creating spaces for transformative moments?

- **Conceptual seminars** provide insights into concepts of, and debates on, sustainable development, global change processes, and emerging dynamics. The seminars provide an opportunity for reflection on the methodological implications of research on global change and sustainable development, conducted using an inter- and transdisciplinary research approach. Special attention is given to the local and national socio-economic and political context that exerts a major influence on the sustainability of livelihoods.
- In **methodological seminars**, students and lecturers discuss how to translate research questions into survey questions and how to implement a survey.
- **Fieldwork preparation:** Students prepare the exploratory fieldwork in groups. They are supported in this endeavour by local resource persons, who provide inputs and answer questions for the group. Each group is accompanied by a coach, who supports and leads the group through their inter- and transdisciplinary discussion and group experiences. Support is particularly necessary where PhD students discuss and interact beyond their disciplinary boundaries and face challenges in real-world contexts.
- The **exploratory survey** serves to formulate a transdisciplinary research strategy, including research questions and hypotheses, methodology, etc. The exploratory survey involves data collection but is not the research itself. Different methods of data collection include studying documents, discussing and interviewing different stakeholders, observing and documenting the environment – all of which are done in relation to the given theme. Fieldwork enables encounters with representatives of other scientific disciplines (interdisciplinarity) as well as with non-academic stakeholders (transdisciplinarity). The case study thus contains thematic, methodological, and ethical issues – and a daily reflection on the fieldwork may spark transformative learning moments. The lecturers act as coaches when needed, and they gradually introduce the relevant tools of the td procedure. The students determine their topic and their own speed of progress, including making mistakes and correcting them. The only deadline is the session before the final presentation to student peers, lecturers, and societal actors.
- **Analysis** is done jointly in groups in preparation for the presentation of findings, supported by the local resource person and a coach.
- **Presentation with feedback:** The output of each case study will be a mock proposal for an inter- and transdisciplinary research project. Each group presents its project, obtaining feedback from the other groups and the coaches, as well as from local resource persons and stakeholders.
- **Scientific Writing** lectures and exercises help develop skills in scientific writing and publishing (including identifying journals in which to publish inter- and transdisciplinary papers). Further sessions are held in research management, career building, and communicating with the public.

### Constructive Alignment 3

How will you assess whether students have achieved the learning outcomes? What **assessment formats** help to determine incremental achievement of the intended competences?

- During all of the above learning activities, students receive feedback from their group coach on the state of their work and their presentations. After the final (public) presentation all other groups, the students' peers, local resource persons, and coaches provide feedback. A final mark is not required.

How and when will you **evaluate the effectiveness** of the teaching–learning arrangements and teaching strategies? What **transformative moments** appeared during the course?

#### Evaluation

At the end of the course, students evaluate all learning activities according to given criteria. For each criterion, they tick on a scale from 0% to 100% to what extent they think the criterion was fulfilled. This visualizes immediately for everyone which parts of the course were successful and which need improvement. Simultaneously, it shows how differently or how homogeneously students rated different parts of the course. Participants are also given small cards on which to specify what they liked most and what needs to be improved. In combination, both parts of the evaluation allow a sound discussion on the perceived quality of the course. A few years after the course, students are asked to complete a tracer survey. This provides additional feedback after participants have had time to *digest* their lessons learned. So far, two tracer studies (Heim et al. 2012, Trechsel et al. 2021) were conducted to document where former participants are working after completion of their PhD, and what they think was the long-term effect of training on their career.

#### Transformative moments (Specific example, Summer School 2019, Abidjan, Côte d'Ivoire)

- For most students, the annual Summer School is the first opportunity to work with colleagues from four continents during an extended period of 10–14 days. Six days of this training are dedicated to preparation, fieldwork, and completion of a case study, where students work in interdisciplinary teams meeting various local or regional actors in their surroundings with real-world problem and solution settings.
- The concept of transdisciplinarity is new to many students and introduced in a theoretical seminar. For scientists who are used to working in mainly disciplinary settings, the concept of “knowledge co-production” is quite provocative, because

- it takes “power” away from researchers and considers other societal actors equally important;
- it challenges the entire interdisciplinary team – all participants and coaches are specialized in one subject and laypersons in all others;
- it requires researchers to subordinate their own research and subject – which some might consider the “most important thing in the world” – under a joint research concept that needs to be negotiated (instead of determined by one researcher).
- For many participants it takes time to get used to this dilemma.
  - After the (theoretical) preparation of the fieldwork, students are “thrown into the unknown”. In Abidjan, this was the thematic combination of research on social conflicts, natural resource management (soils, water, biodiversity), and health;
  - Students met and interviewed different actors: sedentary, mainly Christian farmers; Muslim herders that took care of their animals; and Muslim nomads who were new to the area, driven, among other things, by the effects of climate change (rainfall, water resources, vegetation). Managing emerging social conflicts is not only a matter of appropriate measures to manage natural resources, but rather a question of negotiation and good governance on local and political levels. This dynamic setting of climate and social change becomes a challenge in terms of health care for integrating both human and animal health (“One Health”).
  - Managing the interviews and discussions with all parties requires a certain diplomacy. The problems and demands of the actors become tangible when they are discussed personally outside the classroom in conditions that may be difficult or uncomfortable.
  - Finally, the team needs to agree and present a jointly developed concept on how research could support local actors to find and implement solutions. It is NOT the goal to solve problems on behalf of other people!
- Students enter one new territory after the other when they have to organize themselves with new topics, a new and heterogeneous team, and meeting real-world actors in possibly difficult conditions, etc.
- Social aspects become very important in a transdisciplinary setting, and even emotions – which are normally seen to have no place in science – come into play. It is impossible not to feel empathy for the actors. And teamwork is best achieved in a friendly, cooperative atmosphere.
- The theoretical introduction to td research at the beginning of the course is immediately complemented by practical experience. In addition, this kind of complex setting – or social-ecological system – shows clearly that one’s own research focus is only one among many important factors in finding solutions accepted by all, and that no single discipline or actor group is able to find solutions on its own. Many are surprised to see how td research can contribute to SD.
- All this forces participants to reflect on their current perception of research, of power relations, their role and responsibility as researchers in and for society, and finally, their (taken-for-granted) pathways of thinking and action. Whether or not they will permanently change them, cannot be concluded from this course; however, this type of course is highly suitable to enable transformative moments to occur.

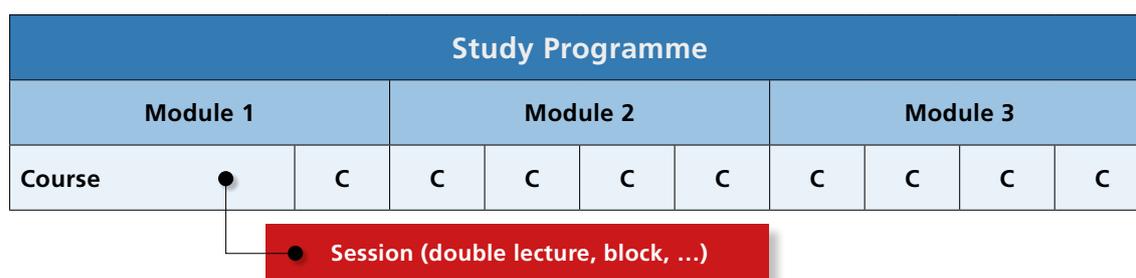
*General conclusions from the IGS North-South Tracer Study (Trechsel et al. 2021):*

- The Summer School setting allows students to develop **attitudes and values** enabling them to address real-world sustainability issues; by doing so they can experience an “*emotional learning edge*”, which can trigger moments of transformative learning.
- Such transformative learning moments in the Summer School course initiates ways of **overcoming the dichotomy of “self” and “other”**, which is hardly focused on in higher education. As students from all over the globe come together during the Summer School, postcolonial structures can come to light. These need to be discussed openly and argued respectfully towards more equitable and sustainable interaction between people and institutions.
- In-depth discussions in groups can trigger **disruptive moments**, which may lead to epistemological insights and mindset changes in the context of a multidisciplinary, multicultural, and multi-institutional reality.
- An absolute prerequisite is a **safe space for learning**, in which people from diverse backgrounds can come together, discuss, listen to each other, learn together, and find compromises. In this environment, beginners are inspired by more advanced scholars; they obtain insights into new fields, and can feel comfortable to share their dreams and visions. Gradually, they get to expand their roles, acting as coaches, lecturers, and learners. At the same time, a safe learning space can enable students to take risks, confront complexity, and step into uncertainty to try new things.
- Coaches play a key role by providing time and structures (e.g. by moderating discussions) to help scholars **overcome apparent dilemmas and states of frustration**.
- In this setting, students can experience **empowering learning moments**. Such moments can foster competences for interacting despite differences, for enriching perspectives, and for forming new friendships.
- When students are nudged towards such learning edges, **reconsider their mindsets**, or dive into a **state of liminality**, they can trigger transformative learning. In our view, in addition to fostering partnership-based research and education, such safe spaces for transformative learning are needed to tackle today’s global challenges (Trechsel et al. 2020).

## 5.5 Inter- and Transdisciplinary Approaches to Analysis and Transformation in Sustainable Development – MSc Minor Programme in Sustainable Development, University of Bern

**Lecturers: Anna Lewis, Cornelia Hett, Karl Herweg**

At times, lecturers may be responsible for only part of a course (e.g. a “session”). In this case, they may not be able to adapt the learning outcomes, assessment, or other basic features of the course as a whole. But they are free to select the didactics and learning methods of their specific session. In this example, therefore, we focus on a session (which may take the form of a lecture, double lecture, block, etc.).



**Figure 21:** Positioning a “session” in the ideal-typical study programme architecture (Design: K Herweg)

### Brief description

The session we are describing takes place within the course “*Inter- and Transdisciplinary Approaches to Analysis and Transformation in Sustainable Development*”. The course itself is part of a compulsory module within the Master Minor in Sustainable Development at the University of Bern (Figure 21). The course is divided into two parts. The first part introduces concepts and theories on analysis and transformation approaches of sustainable development, and clarifies terms, regulatory frameworks, and conceptual transformation perspectives. The second part comprises work on a number of SD-related themes in an interactive form of learning, including selected excursions and visits to external, societal actors. The session we are describing here belongs to the first part of the course, focuses on inter- and transdisciplinarity, and consists of two blocks of four hours each. It follows a general introductory session. Due to restrictions related to the COVID-19 pandemic in the autumn semester 2020, some of the learning content was made available to students via a digital learning platform (LMS). The content for the two thematic blocks was as follows:

- **Repetition and consolidation** of already acquired knowledge on inter- and transdisciplinarity (self-study, quiz)
- **Question and answer session:** opportunity to clarify ambiguities about the topics of the self-study with a lecturer (online)
- **Input** on inter- and transdisciplinary work in practice: experiences of a professional on a research project in Laos (online)
- **Exercise:** reading a text on *Transdisciplinary Research*, three assignments, peer feedback (self-study)
- **Preparation for group work:** read up on the Theory of Change method, self-testing of understanding via three multiple-choice questions (self-study)
- **Group work:** development of a Theory of Change for transformation at higher education institutes: “*What does your (university, or university of teacher education) education look like with regard to sustainable development and the transdisciplinary approach?*”
- **Output:** poster or PowerPoint presentation (in the classroom)

**What are potential links between your discipline and SD?**

In an interdisciplinary team, students are either already aware of potential links between their main subject and SD, or they have the opportunity to identify these during this session.

**What fields of work will the graduates enter?**

The Master Minor in Sustainable Development at the University of Bern is aimed at all disciplines. We anticipate that students will enter employment related to their Major upon graduation. Based on their additional qualification through a Master Minor in Sustainable Development, we can assume that they will work in interdisciplinary teams of scientists in close cooperation with societal actors.

**What typical situations will students have to master within these fields of work?**

Activities in inter- and transdisciplinary teams require and include, among other things, disciplinary expertise, teamwork, conversation skills, empathy, negotiation processes, and self-reflection. Furthermore, members of such teams need to determine their role in the course of each work situation on a different topic and communicate it appropriately, as well as bring in their expertise in a way that is adequate to the respective target group.

**What competences do students need to master these situations?**

Note: The list of competences refers to the whole course; those marked in bold concern the session described above.

Students are able to ...

- **describe inter- and transdisciplinary theories, analysis, and transformation approaches of sustainable development**
- apply approaches to investigate complex socio-ecological systems in the form of case studies in teams, especially approaches relating to the sustainable use of renewable natural resources and overcoming socio-economic disparities
- analyse and summarize societal change processes from different transformation perspectives
- derive possible interventions or starting points as well as critically reflect on their potential effects together with practitioners
- **apply different steps of a transdisciplinary procedure**

**What are the basic organizational conditions of the course?**

This compulsory course takes place annually in the autumn semester. The number of participants varies between 30 to 45 students in the first or second year of their Master's degree. The described example is a session on *inter- and transdisciplinarity* which is designed for eight lessons (two half-days, Monday afternoons 2:00–6:00 p.m.). Most of the students attending the Master Minor in Sustainable Development are majoring in Geography, followed by students studying Social Anthropology, History, and Sports Science. In addition, students from the Universities of Teacher Education in Bern and Lucerne also attend this module as part of their *"Didactics Master's in Nature, Humankind, Society, and Sustainable Development"*.

<b>Action Competence Model</b>	<b>Academic Knowledge</b> <i>knowing ...</i>	<b>Professional Skills</b> <i>mastering ...</i>	<b>Critical awareness (attitude/values)</b> <i>regarding ...</i>	<b>Constructive Alignment 1</b> <b>What are the intended learning outcomes?</b> <i>Students are able to ...</i>
<b>Professional Competence</b> <i>(handling the subject)</i>	<ul style="list-style-type: none"> <li>• inter- and trans-disciplinarity</li> <li>• methods used in td research settings</li> <li>• theory of change</li> </ul>	<ul style="list-style-type: none"> <li>• presenting to peers</li> <li>• providing and receiving constructive peer feedback</li> <li>• recording and presenting the results of group work adequately</li> <li>• reading and understanding scientific papers</li> </ul>	<ul style="list-style-type: none"> <li>• potentials and limitations of td methods</li> <li>• potentials and limitations of td research</li> </ul>	<ul style="list-style-type: none"> <li>• choose and describe a method from the td toolbox, at what point in the research project it could be used, and the goal of using this tool</li> <li>• summarize scientific literature on inter- and transdisciplinary</li> <li>• design a Theory of Change and identify levers for change</li> </ul>
<b>Social Competence</b> <i>handling others)</i>	*	<ul style="list-style-type: none"> <li>• interdisciplinary discourse and teamwork in a group</li> <li>• guided discussion</li> </ul>	<ul style="list-style-type: none"> <li>• respect and support in an interdisciplinary team</li> </ul>	<ul style="list-style-type: none"> <li>• provide constructive feedback on another student's assignments based on given criteria</li> <li>• collectively design a Theory of Change for higher education in an interdisciplinary team</li> <li>• present the results of the group work within the given time and length</li> <li>• communicate their results in an understandable and attractive way to peers</li> <li>• moderate discussion among peers after the presentation</li> </ul>
<b>Personal Competence</b> <i>(handling oneself)</i>	*	<ul style="list-style-type: none"> <li>• planning</li> <li>• time management</li> <li>• self-organization</li> </ul>	<ul style="list-style-type: none"> <li>• reflection on one's own learning process</li> <li>• identifying knowledge gaps</li> <li>• self-efficacy</li> </ul>	<ul style="list-style-type: none"> <li>• reflect on their own learning progress</li> <li>• optimize planning, time management, and self-organization</li> </ul>
*We consider only intrapersonal resources that are essential for the session under discussion				
<p><b>Constructive Alignment 2</b></p> <p><b>What learning activities will help students to achieve these learning outcomes? What learning environments and teaching-learning arrangements support creating spaces for transformative moments?</b></p> <p>The self-study phase allows students to work at their own pace, applying the principles of inter- and transdisciplinarity. Students from different disciplines bring different knowledge and perspectives to the team. The learning content can be tested in a quiz. If students answer incorrectly, hints are provided as to where to find the correct answer, rather than the answer simply being displayed. This encourages students to take responsibility for their own learning progress. After the self-study phase, students have the opportunity to clarify questions or ambiguities with a lecturer. This ensures that all students have attained the same level of knowledge, and it encourages students to address gaps in their knowledge.</p> <p>After the students have acquired theoretical knowledge on inter- and transdisciplinarity, the aim is to connect this knowledge with practice. A lecturer with long-term experience in transdisciplinary research provides an insight into a transdisciplinary research project (in Switzerland and/or abroad) and points out challenges that can arise in the context of transdisciplinary projects. Students are given the opportunity to ask questions.</p> <p>In interdisciplinary group work, students design their own td project, which trains their social and intrapersonal skills as well as their professional skills. Students are encouraged to contemplate their own experience in higher education and to share and exchange their perspectives with peers. Not only do they identify potential levers for change, they also practice communicating in front of an audience in a target group-oriented manner and presenting their results.</p>				

### **Constructive Alignment 3**

**How will you assess whether students have achieved the learning outcomes? What **assessment** formats help to determine incremental achievement of the intended competences?**

Assessment of the entire course consists of formative and summative assessments (reflective questions, short group presentations, and individual essays). During the described session on inter- and transdisciplinarity, students have the opportunity to receive feedback on their learning progress (e.g. through participation in quizzes, written feedback from fellow students, oral feedback from lecturers).

At the end of the session, the learning outcomes are listed again. Students rate their achievement of these outcomes on a scale of 1 to 10. This also give the lecturers a general idea of whether and to what extent the learning objectives have been achieved and in what area students might need additional learning material to further support their learning process on inter- and transdisciplinarity.

**What **transformative moments** occurred during the session?**

- Based on the session alone (two four-hour blocks), it is not possible to conclude whether transformative learning moments took place.
- From the perspective of the entire course, however, the lecturers can conclude if existing perspectives were changed and/or questioned, in particular through the practical relevance of the topics, the excursions, and the exchange with actors.
- We judge the Theory of Change exercise on transformation at universities to have been very successful. The group presentations as well as the subsequent discussions indicate that the students have intensively engaged with their own higher education and have identified levers for change. From our point of view, this has also increased expectations of self-efficacy for the individuals as well as for the team ("*we as students can make a difference, suggest, initiate...*" etc.).

## 5.6 Sustainable Development and Sustainable Land Management – Training of Trainers, Royal University of Agriculture, Cambodia

**Lecturers: Various;** Training of Trainers (ToT) in Cambodia: Isabelle Providoli and Karl Herweg (CDE, University of Bern)

### Brief course description

A course in Sustainable Development (SD) and Sustainable Land Management (SLM) was co-developed by the Royal University of Agriculture (RUA) in Cambodia and the Centre for Development and Environment (CDE), University of Bern, Switzerland. The overall goal of the project was to create a course that would foster sustainable development, and in particular, the sustainable use of natural resources in Cambodia. The Education for Sustainable Development (ESD)-oriented course is aimed at Bachelor's and Master's students at the RUA and at other agriculture-focused higher education institutions in Cambodia. The 64-hour course comprises six units that are divided into 32 hours of lectures and 32 hours of practice. Training of lecturers of the RUA and other institutions in Cambodia took place through the Training of Trainers (ToT) model. The course is specially focused on ESD-oriented teaching and learning, an approach that is new to almost all Cambodian lecturers. The project also produced a teaching manual and teaching-learning materials in English and in Khmer for the course, making it easier for lecturers to implement. The materials include input lectures (PowerPoint presentations), student exercises (instructions/guiding questions for group work and individual work), student handouts, as well as guidelines and exercises for field visits and fieldwork.

#### What are potential **links** between your discipline and **SD**?

The course will educate Cambodian students on sustainability issues and thus capacitate the young generation to address today's challenges of food security, climate change, resource degradation, and poverty. Many of them are likely to encounter these challenges first-hand, in their future work in agriculture development.

In terms of the UN Sustainable Development Goals (SDGs), SDG 4 ("Quality Education") and SDG 15 ("Life on Land") are an opportunity for Cambodia to address quality issues in education in combination with the unsustainable use of natural resources and land degradation. The unsustainable use of natural resources, in particular land, impacts the livelihoods of both rural and urban populations. Land degradation restricts vital ecosystem services such as food and water, affecting people's livelihoods and putting them at increased risk of poverty. The annual cost of land degradation is estimated at USD 677 million, or 8% of Cambodia's Gross Domestic Product. Without a major educational effort, nothing will change. Cambodia has therefore developed and adopted a National Education 2030 Roadmap for SDG 4, which provides the overarching framework for long-term, high-quality, holistic education services.

#### What **fields of work** will the graduates enter?

The majority of the Bachelor's and Master's students at the RUA and other agriculture-focused higher education institutions in Cambodia will work as agricultural officers, among others for the Ministry of Agriculture, Fisheries and Forestry (MAFF) or other governmental, non-governmental, or international organizations. There, they will work on various projects. It is therefore key to capacitate the young generation to address today's challenges of food security, climate change, resource degradation, and poverty.

#### What **typical situations** will students have to **master** within these fields of work?

As professionals, students need to be able to work in different work settings, e.g. in office situations as well as under real-life conditions in the field. They will be confronted with unfamiliar contexts related to the unsustainable use of natural resources and other sustainability issues. It is therefore important that students are able to assess their new work situations quickly, become familiar with different topics, and be open to find solutions to actual challenges by integrating a sustainability perspective. In addition, they need to be able to communicate effectively with team members and societal actors, and to present their work orally and in writing.

#### What **competences** do students need to master these situations?

Students are able to ...

- apply concepts and frameworks in land degradation (LD), sustainable land management (SLM), climate change adaptation & mitigation, and disaster risk reduction in the context of sustainable development, particularly the SDGs
- apply tools and methods to document, assess, and evaluate LD and SLM practices at farm and landscape levels
- develop potential solutions for SLM jointly with farmers and other actors
- monitor the impact of implemented solutions
- communicate adequately with a broad range of actors
- share results in writing (reports, posters) and orally (presentations)

#### What are the **basic organizational conditions** of the course?

This is an annual course for Bachelor's and/or Master's students. The 64-hour course is divided into six units, with 32 hours of lectures and 32 hours of practice.

<b>Action Competence Model</b>	<b>Academic Knowledge</b> <i>knowing ...</i>	<b>Professional Skills</b> <i>mastering ...</i>	<b>Critical awareness</b> <i>(attitude/values) regarding ...</i>	<b>Constructive Alignment 1</b> <b>What are the intended learning outcomes?</b> <i>Students are able to ...</i>
<b>Professional Competence</b> <i>(handling the subject)</i>	<ul style="list-style-type: none"> <li>• sustainable development, SDGs and the UN Conventions</li> <li>• land degradation (LD) and sustainable land management (SLM)</li> <li>• climate change adaptation &amp; mitigation and disaster risk reduction</li> <li>• tools and methods to document, assess and evaluate LD and SLM practices at farm and landscape level (e.g. WOCAT tools)</li> <li>• interview methods, e.g. WOCAT decision-support workshops</li> <li>• structure of scientific reporting</li> <li>• tailor-made products for various target groups</li> </ul>	<ul style="list-style-type: none"> <li>• documenting, assessing, and evaluating LD and SLM in the field through the WOCAT method (transdisciplinarity)</li> <li>• planning, conducting, analysing, and interpreting field surveys.</li> <li>• internet search on specific topics</li> <li>• planning and conducting stakeholder workshops in the field</li> <li>• developing solutions in SLM at farm level</li> <li>• analysing results of stakeholder workshops</li> <li>• writing target-group-specific texts</li> <li>• presenting results of group work to peers and societal actors</li> <li>• constructive peer feedback</li> </ul>	<ul style="list-style-type: none"> <li>• potentials and limitations of field methods</li> <li>• potentials and limitations of SLM solutions (assessing the three SD dimensions)</li> </ul>	<ul style="list-style-type: none"> <li>• explain the concept of SD and summarize key points of the UN Conventions and the SDGs. Explain Cambodia's response to the UN Conventions</li> <li>• list and identify the LD types in the field and apply LD knowledge to the Cambodian context</li> <li>• analyse LD problems holistically, i.e. integrate the three SD dimensions</li> <li>• explain principles of SLM and apply them to different land use types. Explain efforts or inputs needed for prevention, mitigation, and rehabilitation of land degradation (including use of the WOCAT mapping tool)</li> <li>• document SLM practices (Technologies/Approaches) with the WOCAT questionnaires in the field together with the farmer. Enter SLM practices in the WOCAT database correctly</li> <li>• set up a simple monitoring system for SLM</li> <li>• summarize the concept of Ecosystem Services, and analyse the impact a SLM Technology has at farm and landscape level</li> <li>• explain the concept of climate change mitigation and describe the benefits of SLM measures to capture C and reduce C loss</li> <li>• jointly assess and select relevant SLM technologies by using the WOCAT decision-support methodology</li> <li>• elaborate and draw a synthesis of the whole course content</li> </ul>
<b>Social Competence</b> <i>(handling others)</i>	<ul style="list-style-type: none"> <li>• rules and recommendations for conducting fieldwork and interviews</li> <li>• active listening</li> </ul>	<ul style="list-style-type: none"> <li>• structuring a field interview or assessment</li> <li>• techniques of active listening and interviewing</li> <li>• pragmatic division of team tasks</li> <li>• assume responsibility within team</li> <li>• describe complex subjects, target-group oriented</li> </ul>	<ul style="list-style-type: none"> <li>• advantages and disadvantages of teamwork</li> <li>• mutual respect and hospitality of interviewers and interviewees</li> <li>• mutual support in the team</li> </ul>	<ul style="list-style-type: none"> <li>• plan and conduct field assessments related to LD and SLM</li> <li>• plan and conduct WOCAT decision-support workshops in the field with farmers and other actors</li> <li>• conduct respectful and productive field assessments and stakeholder workshops together with farmers and other actors.</li> <li>• structure, analyse, and interpret information gathered through interviews and workshops</li> <li>• document SLM practices within given time and structure</li> <li>• document and communicate workshop results tailored to different target groups</li> <li>• communicate with peers and non-academic actors</li> </ul>

<b>Personal Competence</b> <i>(handling oneself)</i>	<ul style="list-style-type: none"> <li>• individual learning process</li> <li>• expectations of, and conflicts between, different roles in groups</li> </ul>	<ul style="list-style-type: none"> <li>• planning and time management</li> <li>• self-organization of the team during group and fieldwork</li> </ul>	<ul style="list-style-type: none"> <li>• critical reflection of one's own learning process</li> <li>• personal learning process based on practical experience</li> <li>• personal relationship with different actors</li> <li>• perception of one's own role</li> </ul>	<ul style="list-style-type: none"> <li>• reflect on their own learning process</li> <li>• formulate personal field experience</li> <li>• optimize planning, time, and self-management</li> <li>• optimize group work</li> </ul>
<p><b>Constructive Alignment 2</b></p> <p>What <b>learning activities</b> will help students to achieve these learning outcomes? What learning environments and teaching–learning arrangements support creating spaces for transformative moments?</p> <p>The teaching–learning arrangement applied in the SD &amp; SLM course consisted of the following four types:</p> <ul style="list-style-type: none"> <li>• <b>Input lectures:</b> providing students with basic information and knowledge about the given topic.</li> <li>• <b>Exercises/group work:</b> to strengthen team competences, with clear instructions and guiding questions, providing the opportunity for students to apply previously taught knowledge.</li> <li>• <b>Presentation of group work results:</b> practicing communication of results to peers and societal actors, and discussion of the results.</li> <li>• <b>Matching:</b> providing students with feedback on presentation style and contents. N.B. In complex settings such as SLM there is rarely a right or wrong problem-solving technology, but rather, potentials and limitations. In this case, the instructors use a matching exercise (e.g. comparing student results with other projects, etc.) constructing a reference point that helps students to evaluate their group results.</li> </ul> <p>The proposed four types of teaching–learning arrangement usually lasts a whole morning or afternoon. A morning session can easily be conducted as described above. Starting an afternoon session with a lengthy input lecture, however, may find students tired and lacking concentration after lunch. In this case, we propose to start an afternoon with a very short input, e.g. in the form of guiding questions or an exercise. Actively engaging in a group exercise will help students to overcome their fatigue. The input lecture can then be merged with the matching exercise, filling knowledge gaps that become apparent during the exercise.</p> <p>Teaching–learning arrangements that help develop SD-relevant knowledge, skills, and attitude are often a mix of different methods (lecture, exercise, seminar, fieldwork, excursion, etc.). Ideally, field exercises together with farmers and other actors put students into a real-life context. If this is not possible, role-plays in the classroom help to simulate this.</p>				
<p><b>Constructive Alignment 3</b></p> <p>How will you assess whether students have achieved the learning outcomes? What <b>assessment formats</b> help to determine incremental achievement of the intended competences?</p> <p>The course is assessed through formative and summative assessments.</p> <p><b>Formative assessments:</b> during the course students worked in different groups and received continuous feedback on the state of their work, field exercises, and presentations (e.g. oral presentation, poster presentation) from the lecturers and from their peers.</p> <p><b>Summative assessment:</b> in line with Cambodian procedures, two written assessments testing “knowledge and understanding” were conducted. A one-hour mid-term test at the end of unit 2 (out of 6) and a two-hour final exam at the end of the whole course (after unit 6). In the assessments, the students were asked to complete three specific tasks: 1. Summarizing key points of each unit, 2. Identifying the easy parts, and 3. Identifying the difficult parts (“muddiest points”).</p>				

How and when will you **evaluate** the **effectiveness** of the teaching–learning arrangements and teaching strategies? What **transformative moments** appeared during the course?

#### Evaluation

The course was first carried out as a training of trainers (ToT). Later, the course offered to regular students will be evaluated at the end to determine the effectiveness of the teaching–learning arrangements and teaching strategies. Lecturers are obliged to use the official evaluation formats of the university. However, for the first few times the course is held, we recommend applying both formative evaluation during the course as well as summative evaluation at the end. We encourage lecturers to develop also their own evaluation formats, e.g. as multiple-choice questions supported by open key questions (most important lessons learned; rating the course in general; what did you like most; what needs to be improved?). This allows students to reflect thoroughly on their learning progress and enables lecturers to gradually optimize their teaching–learning arrangement.

#### Transformative moments

- In the ToT, we purposely put the participants in the situation where there is no “best” way of solving a problem. Through group work and field exercises they had to identify solutions for existing real-world problems in their country. Simultaneously, they realized that, as lecturers, they are no longer the “specialists” who gradually transfer responsibility and decision-making to students. This situation was completely new for them. Initially, many participants had problems with this way of working; they felt insecure and frequently sought confirmation that they were on the right track. Their main task in the future will be coaching and advising their students to become more confident in their work. This new approach, which challenges both lecturers and students to become more open to new learning methods and settings, makes it possible to experience many individual moments of transformative learning. During the ToT, we observed a lot of enthusiasm that we can connect with innovative teaching–learning methods when knowledge is applied in exercises right after it was introduced.
- Whether or not transformative learning will take place later in the regular courses depends on a number of factors, such as the personal disposition of a student, their social environment, and external triggers. As a first pilot of the course was conducted online (due to the COVID-19 pandemic) in 2020/21, it is not yet possible to conclude whether or not transformative moments occurred. However, the course introduces ESD approaches, which are different compared to the conventional teaching methods widely used in Cambodia, where students seek to accumulate knowledge through learning by heart, but with little critical reflection on what they are learning. Moving from knowledge to action in the course already helps students build competences – in addition to their thematic and methodological skills – that can enable them become agents of change. Establishing such new teaching–learning arrangements in a curriculum will take some time, and requires a close evaluation of the whole process to assess its effectiveness.

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