Case Study

Stefanie Meyer, Katja Brundiers, Marlene Mader, and Annika Weiser

Definition

The term *case* has its etymological roots in the Latin *casus* and literally stands for "a fall", being understood as an "accident" in terms of "a chance, occasion, opportunity" (Harper 2022). Thus, a case study refers to the investigation of a specific event, for example a product, people, or organization, or processes such as policy-making, decision-making, and transformation. It illustrates a rich and multi-layered picture of the selected phenomenon and its setting, which is often characterized by complex circumstances. The aim of a case study is first to gain a better understanding of the phenomenon by investigating and revealing its mechanisms and origins in its specific context, and then to derive lessons learned, which may be transferable to other and future cases. Cases can be real phenomena, fictitious inquiries, or circumstances drawn from the literature. Considering the versatility of case studies, they are applied in many disciplines in research and teaching at higher educational institutes.

Yin (2018) provides general guidelines on planning, preparing, and executing case studies, and sharing results from case study research, which can be adjusted and applied to various disciplines. In general, designing a case study offers choices along several variables: scope (e.g. depth, breadth, and boundedness), function (e.g. theory-testing versus action-oriented problem-solving), and outcome (e.g. theoretical practical insights, lessons learned, policy options), as well as format (e.g. single versus multiple case studies). Single cases may contribute to either confirming or challenging a theory, or to represent a unique or extreme phenomenon, which can be a fictitious inquiry or circumstance drawn from the literature. Single cases require careful investigation to avoid misrepresentation. In contrast, using multiple cases in conjunction with quantitative research approaches allow for cross-case comparison and potential replication of research approaches, holding the possibility of providing findings that are more robust and generalizable or transferable to other cases (Adler et al. 2018; Stake 2013, 39–41). Both single and multiple case studies should use multiple sources of information

to integrate knowledge from the case study with scientific and other pertinent societal discourses. While some disciplines rely on qualitative sources of evidence, such as interviews, observations, documentation (Yin 2018, 111–13), multidisciplinary approaches to complex problem-solving call for mixed-method data collection that integrates qualitative and quantitative resources, such as systems dynamics modeling and formative scenario analysis (Scholz and Tietje 2002).

Transdisciplinary case study research explores socially relevant problems in collaboration with scholars from different disciplines and practitioners from various sectors (Bergmann et al. 2012). To facilitate the collaborative study mode, a transdisciplinary case study typically contains three main phases: (1) joint problem-framing, (2) co-production of knowledge, and (3) integration and application of knowledge (Bergmann et al. 2012; Brundiers and Wiek 2013; Lang et al. 2012).

In sustainability studies, transdisciplinary case studies evolved from conducting research on sustainability problems, resulting in deeper analysis and description of the problem, to studies that also investigate solutions to these sustainability problems. This solutions-oriented research may focus on developing solutions, studying their actual implementation, or evaluating the effects of implemented solutions. In either process, researchers, students, and practitioners can select different degrees of collaboration and co-production of knowledge, ranging from informing and consulting each other to collaborating with potential implementers (e.g. policymakers or NGOs) and affected actors (Lang and Wiek 2022; Lang et al. 2012; Stauffacher et al. 2006). In higher education teaching, transdisciplinary case study approaches offer students opportunities to learn how to methodically approach complex action-oriented problem-solving processes in a collaborative format (Brundiers and Wiek 2013).

Background

The general case study method was first applied at the beginning of the 1900s in qualitative case study research in social and anthropology studies (Platt 1992). Since then, different strands evolved in parallel (Table 1). Various disciplines embraced the problem-centered case study approach, including law, business, and management, as well as educational sciences. Those studies were rather single-case-based, descriptive, and qualitative in nature and were considered as a special form of experimental, statistical, or comparative methods. At the same time, case studies were introduced as a teaching demonstration tool in disciplines such as business, law, and medicine (McNair and Hersum 1954). In these disciplines case studies are continuously used to derive and evaluate knowledge about individuals, groups, and organizations and related social and political phenomena (Carter and Unklesbay 1989).

In the 1950s, systems dynamics offered a new modeling approach for simulating the behavior of real-life social systems (Forrester 1971). Drawing on the advancement in systems thinking and complex real-world problem-solving through Checkland's (1972) soft systems methodology and Meadows' (1999) system-influencing leverage points, it became possible to understand how phenomena change through time and how to direct future developments. Since the 1980s, knowledge on the design of the case study approach and on its process has been solidified (Merriam 1998; Ragin and Becker 1992; Stake 1995; Yin 1981) and case studies were increasingly used in many more disciplines, such as planning sciences, and decision-making and risk research. This fostered the incorporation of scenario planning as a quantitative source of evidence into the environmental case study approach (Gomm et al. 2000). In the mid-1980s, environmental problem-solving emerged as a goal of education, research, and application; the transdisciplinary case study approach was developed at the Eidgenössische Technische Hochschule (ETH) in Zurich (Müller-Herold and Neuenschwander 1992). Since then, universities have adjusted case-based learning courses, providing real-world learning opportunities for students to identify the interdependencies and complexities of (research) problems and striving to integrate pertinent academic disciplines. In the 1990s, the case study approach became more collaborative as more methods and approaches for transdisciplinary collaboration were developed (Scholz et al. 2006), and as participatory action research had advanced in education, combining theory, research, and practice towards a problem-based methodology focusing on theories of action (Carr and Kemmis 1986).

In the 2000s, case studies evolved towards an integration of various types of methods and were used not only to describe and observe phenomena, but also to analyze how to change, fix, and improve contemporary situations. As sustainability science emerged as a research field, solutions- and action-oriented case study approaches were applied in various sustainability-related contexts such as disaster recovery, bioenergy, and precautionary purchasing, vulnerability assessment, or water resource management (Wiek et al. 2012). The concept of sustainability science influenced the learning situations at universities (Stauffacher et al. 2006) and spaces were created to shift the focus from the disciplinary perspective to the inter- and transdisciplinary collaboration of science and practice.

The complex challenges facing societies in the 21st century, such as the climate emergency, increasing urbanization, rising inequalities, and loss of biodiversity (IPCC 2022) expand the focus of case study analysis for transformational change towards advanced participatory research settings and stakeholder involvement as well as capacity-building and better generalization of single and multiple cases (Caniglia et al. 2021; Lang and Wiek 2022; Wiek et al. 2012).

Table 1. Developments in the history of case studies and educational innovations

	Case studies (~1900)	Transdisciplinary research (~1990)	Sustainability Science (~2000)
Learning that is…	– individual – problem-centered – context-related	– collaborative and participatory	– social and participatory – problem- and solution-oriented – competency-based – centered on real-world issues
An epistemology that is…	– descriptive and exploratory	– integrative	– transformational
The investigated phenomenon is…	– mostly a single case – often defined as monodisciplinary	– complex – requiring inter- and transdisciplinary approaches	– complex and difficult to define – requiring transdisciplinary approaches
Applications of case studies…	– in research or teaching	– that combine research and teaching	– that integrate research, teaching and goal of social transformation

Debate and criticism

The co-evolution of case studies as a research method and teaching tool in different disciplines produced diverse approaches to case study work. Thus, the literature contains numerous examples that are referenced as case studies in research, teaching, or practice, but not all of these approaches reflect the characteristics and guidelines for the use and design of case studies (Gerring 2004). Comparing these case studies in attempts to gain generalizable insights remains a challenge, because case studies differ in disciplinary approaches and scope (complexity, context), as well as function and outcome. The multi-methods design of the case study approach is still considered to be a weaker form of analysis compared to a quantitative methods approach, as the latter may promise repetitions, which may increase representativeness, reliability, and validity (Takahashi and Araujo 2020). In either case, interpreting observations requires robust data collection and analysis, as well as competencies including critical thinking and normative and ethical competencies (Takahashi and Araujo 2020). In writing up the results of their case study analysis, researchers need to differentiate results that describe the studied unit and results which may apply to a broader set of units (Gerring 2004). Thus, considering these challenges, common research protocols for case studies

are needed to yield comparable data on influencing variables and to enhance the reliability of cross-case comparisons. Case studies in transdisciplinary sustainability science aim to develop context-sensitive sustainability solutions and an understanding of whether and how such solutions could be transferred to other contexts and what adaptations such transfer might entail (Forrest et al. 2020).

Case study methods are a suitable strategy for teaching and learning about problem-solving competencies to address complex issues. Case study teaching and learning in transdisciplinary settings is a demanding task. Nevertheless, the application of criteria for developing good case study teaching, such as establishing a framework for student discussion and debate, is not as strict (Yin 2018, 19). This allows for adjusting the case study to the level of students being taught, to be relevant to the course content, and to provide a way for students to practice the knowledge and skills they have learned so far in their study program. More emphasis needs to be put on better understanding context conditions across various cases to improve the generation of socially robust knowledge. The implementation of a common framework on self-directed learning and key competencies in sustainability could help support students dealing with the demanding case study work (Brundiers et al. 2021; Pearce et al. 2018; Wiek et al. 2015).

Teaching case studies also demands additional skills from instructors (e.g. coaching, supporting the learning processes). To ensure that case studies as teaching tools can best fulfill their potential, instructors need to be trained in teaching good case studies (Barnes et al. 1994; Brundiers and Wiek 2013; Weber and Kirk 2000). Weber and Kirk (2000) stressed that attempts to align demands and expectations of scientists and practice partners often lead to difficulties. To avoid burdening instructors with additional tasks related to stakeholder collaboration, it is recommended to hire a "Transacademic Interface Manager" – a person who is trained in facilitating transdisciplinary sustainability research and education in collaboration with stakeholders (Brundiers and Wiek 2013). A Transacademic Interface Manager can help facilitate alignment among researchers and stakeholders around shared purposes, by explaining different approaches and developing curricula and standardized protocols (Caniglia et al. 2021). Tools to support collaboration exist and are offered, for example, through platforms like the *td-net* (td-net 2023) and the tdAcademy (2023).

In summary: (1) *Benefits* for students in transdisciplinary and solutions-oriented sustainability case study learning include investigating real-world sustainability issues in collaboration with stakeholders with the goal of co-producing a potentially transformational solution as a motivational driver. This offers valuable opportunities for intellectual, professional, and personal growth as a sustainability change agent. (2) *Challenges* comprise collaborating with stakeholders and diverse scholars in a research-based educational setting requires reconciling different ways of knowing and working, as well as timelines and reward systems.

Finally, (3) to *embrace the challenges*, the interpersonal skills and personal strengths needed for such collaboration can be trained and are valuable professional skills in the workforce (Inner Development Goals, n.d.; Ives et al. 2020). Similarly, skills for inter- and transdisciplinary research can be developed through self-directed learning and seeking out training opportunities offered, e.g. through campus transdisciplinary living learning labs (Fam et al. 2018).

Current forms of implementation in higher education

As discussed above, various disciplines use (transdisciplinary) case studies in research, teaching, and practice and implement them in diverse ways specific to their topics, disciplines, and contexts. Contextual aspects shaping implementation include socio-ecological and cultural dimensions of place as well as the educational and political system of countries (Mieg et al. 2022, 441–43). Selected examples show that sustainability-related challenges and collaborative approaches are gaining momentum in case study implementations.

A case study in the Seychelles addressed the problem of solid waste and involved students and researchers from ETH Zurich and the University of Seychelles, as well as representatives from the Seychelles' Ministry of Environment, Energy and Climate Change, the private sector, and the community. By applying soft systems methodology and design thinking, students learned to better understand the problem and developed place-based and context-sensitive solutions together (Krütli et al. 2018; Pohl et al. 2018). Urban sustainability was addressed within a socio-ecological systems framework in case studies in southern Africa (Thondhlana et al. 2021) and Austria (Biberhofer and Rammel 2017). They investigate challenges, such as poor sanitation and power supply in different southern African urban areas and increasing CO_2 emissions and limited fossil resources in Austrian cities, respectively. Case studies in Mexico, Colombia, Nicaragua, and China (Transdisciplinary Student Team Research) investigated rural development accounting for local conditions (Acevedo-Osorio et al. 2020). Students were engaged in problem-based- and co-learning with peers to develop responsible actions that support sustainable rural development.

These examples highlight the spectrum of teaching and learning approaches ranging from student-centered, experience-based service learning to approaches that aim to increase broader social learning in transdisciplinary learning. The examples also illustrate how learning objectives for students combine, in varying degrees, content knowledge, professional skills, and sustainability competencies to create a meaningful teaching and learning environment in higher education. As such, they emphasize the need to provide good teacher training offerings when implementing such complex teaching innovations. Real-world laboratories sup-

port long-term learning and teaching at the science–society interface, engaging students with all phases of transdisciplinary research, including framing the project as well as developing and testing solutions, and evaluating processes and outcomes (Barth et al. 2017; Beecroft 2018; Singer-Brodowski et al. 2018). Thus, in conclusion, the examples show how transdisciplinary case studies may vary, ranging from a traditional focus on a deep understanding and co-development of the problem in its context to an emphasis on co-designing solution approaches and using gained knowledge to advance science and practice.

References

Acevedo-Osorio, Álvaro, Susanne Hofmann-Souki, and Juana Cruz Morales. 2020. Holistic competence orientation in sustainability- elated study programmes: Lessons from implementing transdisciplinary student team research in Colombia, China, Mexico and Nicaragua. *Sustainability Science* 15 (1): 233–46.

Adler, Carolina, Gertrude Hirsch Hadorn, Thomas Breu, Urs Wiesmann, and Christian Pohl. 2018. Conceptualizing the transfer of knowledge across cases in transdisciplinary research. *Sustainability Science* 13 (1): 179–90.

Barnes, Louis B., C. Roland Christensen, and Abby J. Hansen. 1994. *Teaching and the case method: Text, cases, and readings*. Brighton, MA: Harvard Business School Press.

Barth, Matthias, Daniel J. Lang, Philip Luthardt, and Ulli Vilsmaier. 2017. Mapping a sustainable future: Community learning in dialogue at the science–society interface. *International Review of Education* 63 (6): 811–28.

Beecroft, Richard. 2018. Embedding higher education into a real-world lab: A process-oriented analysis of six transdisciplinary project courses. *Sustainability* 10 (10), 3798.

Bergmann, Matthias, Thomas Jahn, Tobias Knobloch, Wolfgang Krohn, Christian Pohl, and Engelbert Schramm. 2012. *Methods for transdisciplinary research: A primer for practice*. Frankfurt: Campus Verlag.

Biberhofer, Petra, and Christian Rammel. 2017. Transdisciplinary learning and teaching as answers to urban sustainability challenges. *International Journal of Sustainability in Higher Education* 18 (1): 63–83.

Brundiers, Katja, and Arnim Wiek. 2013. Do we teach what we preach? An international comparison of problem- and project-based learning courses in sustainability. *Sustainability* 5 (4): 1725–46.

Brundiers, Katja, Matthias Barth, Gisela Cebrián, Matthew Cohen, Liliana Diaz, Sonya Doucette-Remington, Weston Dripps, Geoffrey Habron, Niki Harré, Meghann Jarchow, Kealalokahi Losch, Jessica Michel, Yoko Mochizuki, Marco Rieckmann, Roderic Parnell, Peter Walker, and Michaela Zint. 2021. Key

competencies in sustainability in higher education – Toward an agreed-upon reference framework. *Sustainability Science* 16: 13–29.

Caniglia, Guido, Christoph Lüderitz, Timo von Wirth, Ioan Fazey, Berta Martín-López, Kristina Hondrila, Ariane König, Henrik von Wehrden, Niko Alexander Schäpke, Manfred D. Laubichler, and Daniel J. Lang. 2021. A pluralistic and integrated approach to action-oriented knowledge for sustainability. *Nature Sustainability* 4 (2): 93–100.

Carr, Wilfred, and Stephen Kemmis. 1986. *Becoming critical: Education, knowledge and action research*. London: Falmer.

Carter, Kathy, and Rick Unklesbay. 1989. Cases in teaching and law. *Journal of Curriculum Studies* 21 (6): 527–36.

Checkland, Peter B. 1972. Towards a systems-based methodology for real-world problem solving. *Journal of systems engineering*, 3(2), 87-116.

Fam, Dena, Abby Mellick Lopes, Alexandra Crosby, and Katie Ross. 2018. The university campus as a transdisciplinary living laboratory. Available from https://i2insights.org/2018/05/01/campus-as-transdisciplinary-living-laboratory.

Forrest, Nigel, Zoë Stein, and Arnim Wiek. 2020. Transferability and scalability of sustainable urban water solutions – A case study from the Colorado River Basin. *Resources, Conservation and Recycling* 157: 104790.

Forrester, Jay W. 1971. *World dynamics*. Cambridge, MA: Wright-Allen Press.

Gerring, John. 2004. What is a case study and what is it good for? *American Political Science Review* 98 (2): 341–54.

Gomm, Roger, Martyn Hammersley, and Peter Foster, eds. 2000. *Case study method: Key issues, key texts*. London: Sage.

Harper, Douglas. 2022. *Etymology of case*. Online etymology dictionary. Available from https://www.etymonline.com/word/case.

IPCC [Intergovernmental Panel on Climate Change], ed. 2022: *Climate change 2022: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press.

Inner Development Goals. n.d. Available from https://www.innerdevelopmentgoals.org.

Ives, Christopher D., Rebecca Freeth, and Joern Fischer. 2020. Inside-out sustainability: The neglect of inner worlds. *Ambio* 49: 208–17.

Krütli, Pius, Christian Pohl, and Michael Stauffacher. 2018. Sustainability learning labs in small island developing states: A case study of the Seychelles. *GAIA – Ecological Perspectives for Science and Society* 27: 46–51.

Lang, Daniel J., and Arnim Wiek. 2022. Structuring and advancing solution-oriented research for sustainability. *Ambio* 51 (1): 31–35.

Lang, Daniel J., Arnim Wiek, Matthias Bergmann, Michael Stauffacher, Pim Martens, Peter Moll, Mark Swilling, and Christopher J. Thomas. 2012. Transdisci-

plinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science* 7: 25–43.

McNair, Malcolm Perrine, and Anita C. Hersum, eds. 1954. *The case method at the Harvard Business School: Papers by present and past members of the faculty and staff*. New York: McGraw-Hill.

Meadows, Donella. 1999. *Leverage points: Places to intervene in a system*. The Sustainability Institute. Available from http://drbalcom.pbworks.com/w/file/fetch/35173014/Leverage_Points.pdf.

Merriam, Sharan B. 1998. *Qualitative research and case study applications in education. Revised and expanded from "Case Study Research in Education"*. San Francisco: Jossey-Bass.

Mieg, Harald A., Elizabeth Ambos, Angela Brew, Dominique M. Galli, and Judith Lehmann, eds. 2022. *The Cambridge handbook of undergraduate research*. Cambridge: Cambridge University Press.

Müller-Herold, Ulrich, and Markus Neuenschwander. 1992. Vom Reden Zum Tun: Die Fallstudie in Den Umweltnaturwissenschaften. *GAIA – Ecological Perspectives for Science and Society* 1 (6): 339–49.

Pearce, BinBin, Carolina Adler, Lisette Senn, Pius Krütli, Michael Stauffacher, and Christian Pohl. 2018. Making the link between transdisciplinary learning and research. In *Transdisciplinary theory, practice and education*, eds. Dena Fam, Linda Neuhauser, and Paul Gibbs, 167–83. Cham: Springer.

Platt, Jennifer. 1992. "Case study" in American methodological thought. *Current Sociology*, 40 (1):, 17–48.

Pohl, Christian, Pius Krütli, and Michael Stauffacher. 2018. Teaching transdisciplinarity appropriately for students' education level. *GAIA – Ecological Perspectives for Science and Society* 27 (2): 250–52.

Ragin, Charles C., and Howard S. Becker, eds. 1992. *What is a case? Exploring the foundations of social inquiry*. Cambridge: Cambridge University Press.

Scholz, Roland W., and Olaf Tietje. 2002. *Embedded case study methods: Integrating quantitative and qualitative knowledge*. Thousand Oaks, CA: Sage.

Scholz, Roland W., Daniel J. Lang, Arnim Wiek, Alexander I. Walter, and Michael Stauffacher. 2006. Transdisciplinary case studies as a means of sustainability learning: Historical framework and theory. *International Journal of Sustainability in Higher Education* 7 (3): 226–51.

Singer-Brodowski, Mandy, Richard Beecroft, and Oliver Parodi. 2018. *Learning in real-world laboratories: A systematic impulse for discussion. Gaia* 27: 23–27.

Stake, Robert E. 1995. *The art of case study research*. London: Sage.

Stake, Robert E. 2013. *Multiple case study analysis*. New York: Guilford.

Stauffacher, Michael, Alexander I. Walter, Daniel J. Lang, Arnim Wiek, and Roland W. Scholz. 2006. Learning to research environmental problems from a functional socio-cultural constructivism perspective: The transdisciplinary

case study approach. *International Journal of Sustainability in Higher Education* 7 (3): 252–75.

Takahashi, Adriana R. W., and Luis Araujo. 2020. Case study research: Opening up research opportunities. *RAUSP Management Journal* 55 (1): 100–11.

tdAcademy, ed. 2023. *About us*. Available from https://td-academy.org/en/tdacademy/about-us.

td-net, ed. 2023. *Network for transdisciplinary research*. Available from https://transdisciplinarity.ch/en.

Thondhlana, Gladman, Chipo Plaxedes Mubaya, Alice McClure, Akosua Baah Kwarteng Amaka-Otchere, and Sheunesu Ruwanza. 2021. Facilitating urban sustainability through transdisciplinary (TD) research: Lessons from Ghana, South Africa and Zimbabwe. *Sustainability* 13 (11): 1–18.

Weber, Mary M., and Delaney J. Kirk. 2000. Teaching teachers to teach cases: It's not what you know, it's what you ask. *Marketing Education Review* 10 (2): 59–67.

Wiek, Arnim, Barry Ness, Petra-Schweizer-Ries, Fridolin S., Brand, and Francesca Farioli. 2012. From complex systems analysis to transformational change: A comparative appraisal of sustainability science projects. *Sustainability Science* 7 (Supplement 1): 5–24.

Wiek, Arnim, Michael Bernstein, Rider W. Foley, Matthew Cohen, Nigel Forrest, Christopher Kuzdas, Braden Kay, and Lauren Withycombe Keeler. 2015. Operationalising competencies in higher education for sustainable development. In *Routledge handbook of higher education for sustainable development*, eds. Matthias Barth, Gerd Michelsen, Marco Rieckmann, and Ian Thomas, 241–60. Abingdon: Routledge.

Yin, Robert K. 1981. The case study as a serious research strategy. *Knowledge: Creation, Diffusion, Utilization* 3 (1): 97-114.

Yin, Robert K. 2018. *Case study research and applications: Design and methods*. 6th edition. Thousand Oaks, CA: Sage.