

Designing Field Exercises with the Integral Approach for Sustainability Science: A Case Study of the Heihe River Basin, China

Ricardo O. San Carlos, Heng Yi Teah, Tomohiro Akiyama and Jia Li

Abstract This chapter introduces one of the GPSS-GLI exercises, the Oasis Unit, which has been conducted annually in northwestern China. The unit aims to equip the students who take it with a wide knowledge base and leadership competency, and is thus strongly field-oriented. The Integral Approach proposed by Ken Wilber is applied when designing this unit, which provides an interdisciplinary and trans-disciplinary framework for synthesizing the complex problems of sustainability, as well as allowing the inclusion of methodologies from different academic fields. In the present chapter a practical implementation of the approach is showed and discussed, using as a case study the 2015 Oasis Unit within two contexts—(1) as a holistic framework for addressing sustainability problems, and (2) as a design approach for educational field exercises. Finally, the authors summarize the usefulness of the integral approach in designing field exercises based on the seven year long experience of the University of Tokyo in organizing the Oasis Unit.

Keywords Integral approach · Sustainability science education · Field exercise · Heihe river basin

This chapter is an updated version of Akiyama et al. (2010) and Akiyama and Li (2013).

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1 Introduction

The United Nations Decade of Education for Sustainable Development (UNDESD), initiated in 2005, aims to develop and implement educational programs that focus on the three pillars of sustainability, i.e., environment, economy, and society. The Graduate Program in Sustainability Science—Global Leadership Initiative (GPSS-GLI, at the University of Tokyo) was established in line with the Japanese government's initiative to promote sustainability science education in higher education institutions and to nurture global leaders. Since the concept of sustainability science and present-day sustainable development problems feature complex issues, GPSS-GLI has paid considerable attention to interdisciplinary and/or transdisciplinary education. Particularly, through the GLI component of the program the focus is on fostering student leadership through on-site curriculum.

The core of the on-site curriculums are three courses that are known as “Field Exercises”, built for the purpose of practical learning. These include Resilience Exercises (RE) and Global Field Exercises (GFE) for master students, and Global Leadership Exercises (GLE) for doctoral students. To guarantee the diversity of education methodologies and educational effects, the field exercise units can be roughly classified as either field-oriented or structure-oriented. In either case, the course consists roughly of four parts: preliminary learning, on-site learning, after-the-fact learning, and a joint task (report preparation and a presentation). Field-oriented exercises develop leadership mainly through student-based group work that consists of reviewing literature, planning on-site research activities, implementing field surveys and presenting the results of the study. Doctoral students who participate in GLE are responsible to coordinate and lead one RE or GFE unit. Akiyama et al. (2012a) mentioned that field-oriented exercises foster global leadership mainly through the execution of field surveys, while the structure-oriented exercises develop leadership through a series of educator-structured programs (i.e., in-class lectures, discussions, and short field trips). Students in GPSS-GLI are diverse in terms of their undergraduate academic disciplines and cultural backgrounds, i.e., 54 graduate students from 20 countries. A holistic framework that emphasizes pluralism and the integration of scientific knowledge, and that is not aiming to establish a single theory (Olsson et al. 2015), is therefore needed in guiding the design of field exercises.

This chapter provides a detailed description of one of the field exercises, the Oasis Unit, which has been conducted annually in the period 2009–2015 in the Heihe River basin in arid northwestern China. The Oasis Unit especially emphasizes on the multidisciplinary of sustainability science education and the necessity for a holistic view to understand the various dimensions of development issues in the region. Therefore, it makes an effort to incorporate the Integral Approach, adapted from the American philosopher Wilber (2001), into the practice of sustainable development leadership education. The authors introduce the four-quadrant framework of the Integral Approach and two methods of applying the framework in Sect. 2; describe the background of the Oasis unit and the fieldwork carried out

through it in Sect. 3; show a case study on 2015 Oasis Unit in Sect. 4; and discuss the applicability of Integral Approach in designing field exercises for sustainability science education in the last section of this chapter.

2 Integral Approach: A Simplified Introduction

2.1 A Four-Quadrant Framework

The Integral Approach aims to incorporate multiple perspectives instead of focusing on specific objects and/or specific systems of objects. Given the complexity of reality, the Integral Approach cuts across fields and brings together existing methodologies into an interdisciplinary and transdisciplinary framework. According to Wilber (2001), all phenomena in the world can be categorized into four groups using a quadrant framework. These quadrants present four ways of viewing the same occurrence in reality from four different perspectives. They are located in the interior and exterior of both individuals and collectives. The exterior aspects are found on the right-hand side, with physical and behavioral aspects in the upper right quadrant, and social systemic aspects in the lower right quadrant. The interior aspects are found on the left-hand side, with intentional, personal, and psychological aspects in the upper left quadrant and cultural aspects (collective values) in the lower left quadrant. Although the four quadrants are ontologically distinct there is nevertheless an interwoven, intimate relationship between them.

Wilber's Integral Approach has received substantial attention and has been applied to a variety of fields, in both academia and practice. In particular, it is gaining attention around the world from researchers and practitioners in the field of sustainability science and environment studies. It has also been previously applied to the fields of development and education. In the field of international development, several international development organizations and non-governmental organizations, including the United Nations Development Program (which started a global leadership development program around HIV/AIDS), are increasingly seeing the advantages of adopting this approach to their projects (Brown 2006). At the local level, this approach has also been used in community development projects such as the one in the San Juan del Gozo community in El Salvador (Hochachka 2008). In the field of education, the approach has also proved useful for curriculum development: see, for example, Gidley and Hampson (2005), Lloyd (2007) and Akiyama et al. (2012a). In the present chapter the authors apply this approach because, first, it provides a holistic framework encompassing a wide knowledge base in the social, economic, cultural, and natural sciences, and second, it leads to the successful implementation of a global leadership education program by providing a comprehensible structure for educational curriculum design. Particularly, the authors will depict and use the quadrant model in two ways: a Quadrivia approach for solving sustainability problems, and a Quadrant approach for the field exercise educational design.

2.2 *Quadrivia Approach for Solving Sustainability Problems*

Quadrivia, in Latin, means a place where four roads meet. According to the four-quadrant framework (Fig. 1), the Quadrivia approach places a research problem in the center and find solutions from four dimensions, i.e., interior, exterior, individual, and collective. In practice, a research question must first be defined, and then the research methodologies in different fields and disciplines can be cohesively included to answer the question. Structuring a research with this approach is holistic, at least in the interdisciplinary and transdisciplinary context. Figure 1, for example, is a version of Akiyama et al. (2010)’s four-quadrant framework related to water environmental issues. The study covered the objective components, which include hydrological processes and water management systems, and the subjective components, which include personal values and culture.

The authors would like to draw attention on the following studies: Kayane et al. (2006), Kayane (2008a), which pioneered the application of this approach to water environment issues. These authors analyzed the water environment and related changes in Lijiang City, China and Tsuwano Town, Shimane Prefecture, Japan. They argued that, first, the natural environment, especially water, is a common element related to all quadrants, and second, that current environmental problems are often consequences induced by the abnormal development (evolution) of the lower right quadrant, i.e., rapid technological innovation in the 20th century. The authors refer to such work because the main topic of the Oasis Unit is water scarcity and

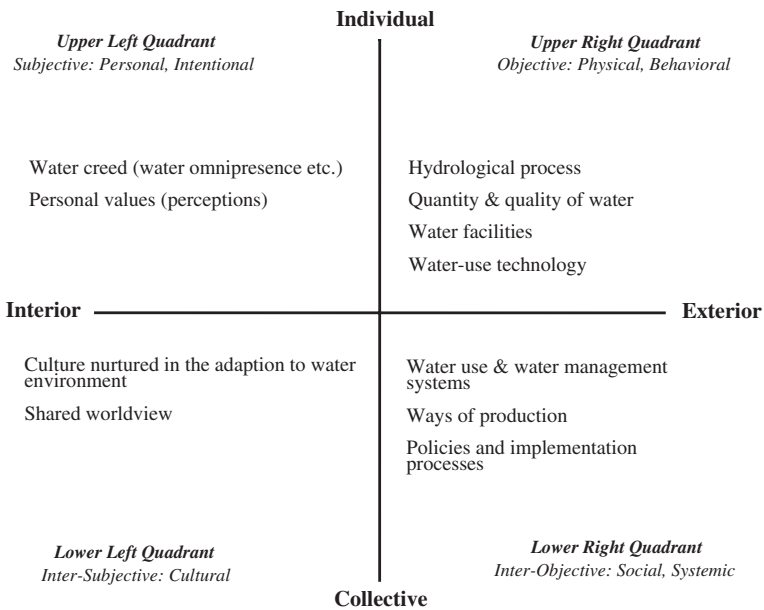


Fig. 1 Akiyama et al. (2010)’s four-quadrant framework related to water environmental issues

water resource management in arid regions. The framework outlined in Kayane et al. (2006) and Kayane (2008b) was further developed in Akiyama et al. (2012b).

The framework used in the present chapter allocates perspectives on water environmental issues into each of the four quadrants. It draws on the philosophy of sustainability science and environment studies, with its emphasis on empirical research methods (quantitative and scientific), as well as philosophy, to encompass inter-subjective and subjective modes of inquiry (qualitative and social-value oriented). The benefit of this framework, although requiring further research, is profound. It offers a common foundation to view the various perspectives on the complexity of water environmental issues. In other words, it incorporates knowledge and methodologies from multiple disciplines.

2.3 Quadrant Approach in the Development of Field Exercise Education

The integral approach presents some advantages in tackling sustainability or environmental issues, but it is not the only way that the framework can be utilized within the Oasis Unit. Since the Oasis Unit is part of a research and educational program, it is imperative that its design considers not only the methodologies to address the object of study (Quadrivia) but also how it will impact the learning and growth of the individuals/students involved (Quadrant). Thus, in this section the authors will discuss the characteristics of the integral approach for the design of a field exercise like the Oasis Unit. For this discussion the authors will focus on the application of the integral approach to the conceptual design of a field-based and problem-oriented educational program, while addressing its advantages, limitations, opportunities and challenges. Finally, the authors will reflect on the case study of the Oasis unit carried out in summer of 2015.

In Fig. 2, “I” (or “we”) refers to the participant(s) of the field exercise. The framework first requires fostering self-development through personal learning as well as group work, collaboration and communication with the different stakeholders. Then, it also requires all participants to achieve common conclusions, as well as to accommodate their individual views. Therefore, the field exercise should provide enough time and resources for the participants to reach a consensus and to set shared clear goals from the beginning, while also allowing for individual points of view.

Considering the design of a field exercise, the educational goals of the program should generally be stated beforehand. The set of competencies expected as a result of the field exercise could constitute the main outcome from the point of view of an individual’s learning and growth as a sustainability researcher. The issue at hand is that the necessary competencies for sustainability scholars are still matter of debate. Although there are some important studies regarding the competencies in sustainability science (Wiek et al. 2011), these are not yet completely accepted across all sustainability programs and institutions.

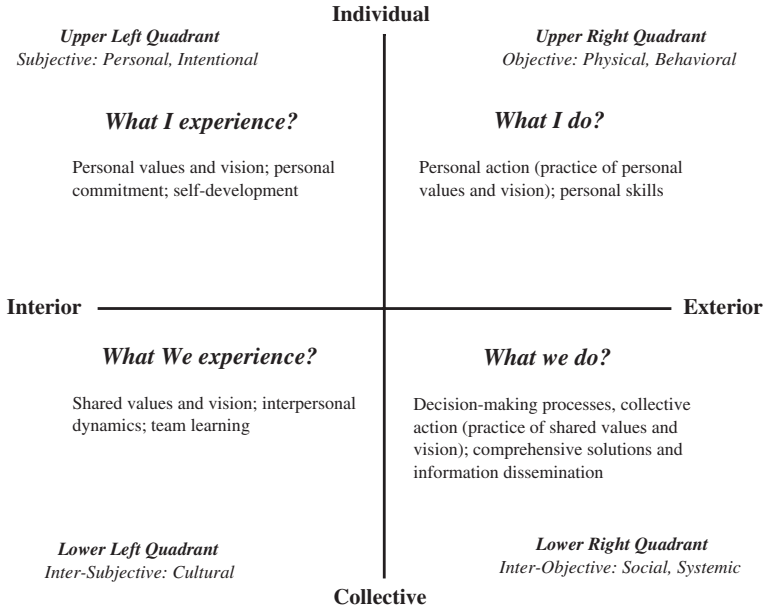


Fig. 2 An integral framework for designing the education process of field exercises

An alternative to the discussion of the competencies necessary for sustainability science could be found in the application of the integral approach. Instead of focusing on the expected outcomes, the design could be focused on the experience of the individual during the field exercise. According to the integral approach, every experience can be understood by applying the 4 irreducible dimensions described by the quadrants. In this way, what is relevant when designing a field exercise is to provide individuals with experiences that allow them to reach desired levels of depth and complexity within each quadrant. Then, the focus is not on identifying a specific set of competencies to develop, but on designing different experience channels for the individual that relate to sustainability issues (Esbjörn-Hargens 2005). In turn this will translate into deeper and more complex levels of learning for the individual in all four dimensions of the quadrant.

3 Applying the Integral Approach to Field Exercises

3.1 Oasis Unit in Northwestern Arid China

The Heihe River basin in arid northwestern China is an excellent area for field-work participants to consider how sustainable development could be achieved in dryland regions under severe water resources constraints. The University of

Tokyo's Asian Program for Incubation of Environmental Leaders (APIEL), later succeeded by GPSS-GLI, chose this river basin specifically as a target area for field exercise for the two reasons detailed below.

First, the sustainable development of dryland regions is one of the major challenges facing the planet nowadays. It is associated with water security as well as food security around the world. Today, irrigated agricultural land makes up less than one-fifth of the total cultivated area in the world, but produces about two-fifths of the world's food (Pirages 2000). Irrigation farming, to a great extent, contributed to the increase in food production in the 20th century, and continues to support the planet's growing population. However, food production -relying on the "irrigation miracle"—has a significant impact on water resources. Agricultural water use, including irrigation, accounts for about 70 % of global water usage (Shiklomanov 2000). In dryland regions, large-scale development of irrigation farming has induced dramatic increases in water demand. Consequently, it often results in the stoppage of river flows, dry-up of lakes, decline of groundwater tables and other related ecosystem degradation.

Second, the Heihe River basin, the second largest inland river in China, provides many topics for the study of sustainable development in dryland regions. For the case of the Oasis Unit these include watershed management, water-saving policies (decision-making processes, implementation and assessment), as well as environmental degradation and recovery. In the Heihe River basin, historically, people living in the middle and lower reaches have adopted different ways of production, namely irrigation farming (settled culture) in the middle reaches and nomadic husbandry in the lower reaches. Intensive agricultural practices in the middle reaches since the 1950s have resulted in a dramatic degradation of the environment downstream (in the lower reaches). Conflicts over water use between people living in the middle reaches and those living in the lower reaches dates back to at least 200 years ago (Inoue 2007). However, these conflicts have never been as fierce as today. The intensive exploitation of water resources in the middle reaches has cut the water flow to the lower reaches. By 2002, more than 30 tributaries of the Heihe River basin had dried up. In the lower reaches, two terminal lakes dried up in 1961 and 1992. Riparian vegetation degraded. Salinization and desertification intensified. The desertification is attracting substantial attention nationwide and is thought to be the origin of dust storms in the spring.

In recent years, a range of environmental conservation activities has been carried out in the river basin, particularly around Zhangye, a city in the middle reaches of the Heihe River basin. The main purpose of environmental conservation activities is to preserve the environment in the lower reaches. At the core of those activities is the Integrated Water Resources Management Plan of the Heihe River basin, promulgated by the Chinese state council in 2001. This plan states that "when the water from the upstream discharge reaches 1.58 billion m³/a, Zhangye, located in the middle reaches of the Heihe River basin, has to increase discharge 0.225 billion m³/a to the lower basin, which means 0.95 billion m³/a should be released to the downstream" (Fang et al. 2007). In other words, the central

government requires the city of Zhangye to reduce water consumption by means of an administrative order. Since 2001, Zhangye has been repeatedly selected as an experimental site for pilot programs for water resource management. In early 2002, the Ministry of Water Resources of China initiated an experimental project for establishing a water-saving society in the middle reaches at Zhangye. The project was set to save water and increase water use efficiency, mainly in two ways: (1) by building concrete irrigation channels using government funds; (2) by introducing market mechanisms. The policies include the introduction of meters to charge for irrigation water based on the amount used, and the introduction of a water use rights system with tradable water quotas. At the same time, in Ejina (in the lower reaches) a relocation policy has been implemented, as overgrazing in the area was considered one of the reasons behind the environmental degradation.

3.2 Integral Design of the Oasis Unit

Applying the Integral Approach to global leadership education is an evolving process that is far from complete. There are external constraints, such as those on human resources, finances and time, which prevent the ideal development of a program. In addition, students, who have come through a relatively narrow educative system, do not always know how to respond to a new, holistic way of learning. Therefore, during the design the Oasis Unit educators need to focus on an integral knowledge base as well as integral practices.

Started in 2009, the Oasis Unit has taken place once a year up to the time this chapter was written. With integral thinking as the general framework for program design, its organizers have extended the content of the field exercise to incorporate perspectives related to environmental issues, and provided more experiences so that students could develop practical skills. The field exercise is jointly organized by GPSS-GLI, The University of Tokyo, and the Cold and the Arid Regions Environment and Engineering Research Institute (CAREERI), of the Chinese Academy of Sciences. Students who join the field exercise belong to either of these institutes, and come from different countries and undergraduate backgrounds. To provide the students with multi-disciplinary knowledge and multiple views about local environmental problems, faculty members from different academic fields as well as local stakeholders are typically involved in the different stages of the fieldwork. Its organizers have established close relationships with the local water authority to move beyond the boundaries between academia and stakeholders, as well as to let students know that they are tackling real-world problems. Students are required to make policy recommendations and deliver this information to the local water authority. In addition, in 2011 and 2012, the collaboration was strengthened by working with several other institutions from both Japan and China. Organizers have thus held international symposia in Japan and in China to build a platform for students to hear fresh voices from academia beyond faculty members, government officials, and business people.

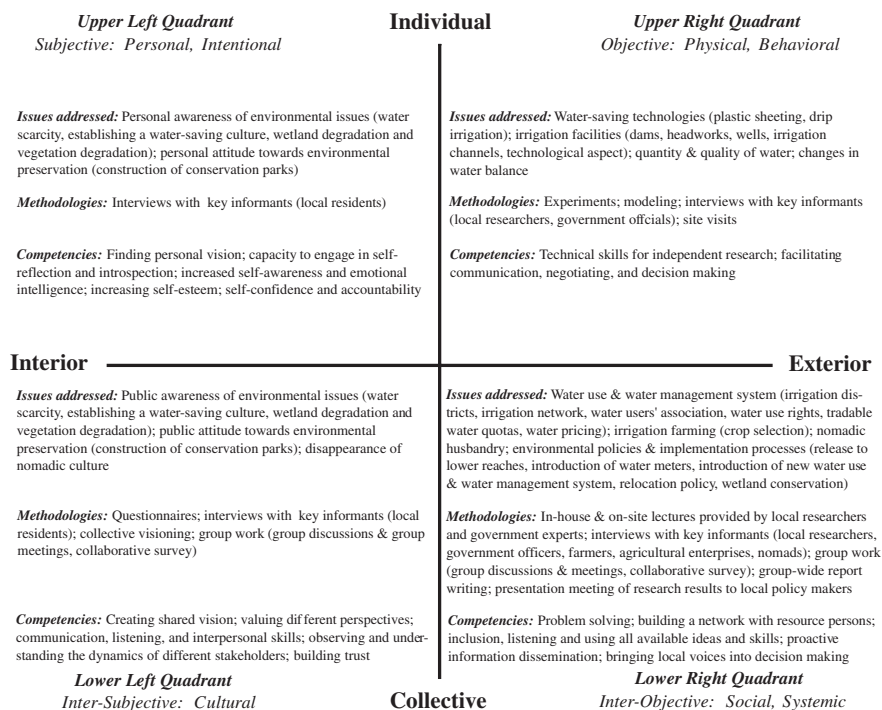


Fig. 3 An integral organizational framework for Oasis Unit (Akiyama and Li (2013))

Figure 3 is an overview of the organizational framework used in the field exercise. Note that students are the leading players. Educators simply created the space for students to see real-world environmental problems and to realize their own development. In Fig. 3, environmental issues (*Issues addressed*) are the research topics covered by the students; *methodologies* are those adopted by the students; and *competencies* are the capabilities and/or skills that students are expected to have after participating in the field exercise.

Problem-solving based learning is the core concept of the course design. It reveals related issues, brings together the necessary research methodologies, and consequently improves participants' competence to become global leaders in the future. The main objective of the field exercise is to enhance the students' practical skills through solving specific environmental problems in the real world. Issues in each quadrant have different perspectives for the same environmental problem: the sustainable development of the Heihe River basin, which is facing severe water shortages. The issues are interwoven. To provide comprehensive solutions for multiple issues, different methodologies from diverse fields are required. Though they cut across quadrants, natural science methods, including experiments and quantitative modeling, are mostly required to tackle the issues in the upper right quadrant. For the lower right quadrant, social science methods are mostly required. In

the case of the two left-side quadrants, humanity-based, hermeneutic methods are mostly required.

The competencies that were identified in Fig. 3 were not intentionally selected by the organizers. They developed naturally in the process of participating in fieldwork, in particular through group work (which requires the students to listen to, understand, and assimilate different ideas). Students need to find common research interests and decide on common research topics, as well as adapt to change, and finally to solve the problems. In addition, competencies spill over to other quadrants. For example, good communication skills may foster students' understanding of the variety of stakeholder concerns, to create a shared vision, and to integrate methodologies and fields to find comprehensive solutions.

4 Case Study of 2015 Oasis Unit

The 2015 Oasis unit was started in May, with the fieldwork being conducted from the 1st to 14th August in Lanzhou and Zhangye. Members of the unit consisted of one doctoral student, four master students, and three faculty members. Collaborative members were students and faculty from Sophia University, Tokyo University of Agriculture and Technology, and CAREERI, 53 members in total.

4.1 *Designing Sustainability Assessment in Quadrivia View*

Before defining the research theme, students were advised to review the 25 top-cited and the 25 latest literatures about the region, as outlined in the Web of Science platform. The keywords “Heihe River basin” and “Zhangye” were used as filters. The results encompassed literature from a wide range of disciplines, including hydrology, remote sensing, decision-making modeling, land-use and cover-change, water management, economics, and policy analysis. The literature provided rich reference to formulate an integrated study. Students were then encouraged to propose research projects under the umbrella of sustainable development. A supplement of project reports written by previous Oasis Units was provided as references. Proposals were made mainly based on students' personal interest or their initial training (i.e., environmental science and engineering, civil engineering, economy, and literature study).

A research theme, “A Planetary Boundary based Framework for Sustainability Assessment of Heihe Middle Reaches”, was finally agreed upon by all members. It used the point of view of Planetary Boundaries (Rockstrom et al. 2009; Steffen et al. 2015), defining sustainability as the development of human activities that do not transgress ecological limitations, for carrying out the Oasis regional sustainability assessment. First, the nine global boundaries proposed in Planetary Boundary (Steffen et al. 2015) were reduced to five ecosystem boundaries, i.e.,

freshwater use, biogeochemical flow, atmospheric aerosol loading, novel entities, and land-system change, based on the existence of regional thresholds. The measurable indicators and the values for each boundary were then downscaled to the local level to reflect the ecosystem in the region (Cole et al. 2014; Dearing et al. 2014). Environmental data for the study area, the middle reaches of Heihe River basin, was collected and analyzed. The result showed that the freshwater use of the region is at high-risk level, and that it critically outweighed other boundaries.

In order to provide useful recommendation to the local government, the unit performed an attempt to simulate how economic activity contributed to each boundary. First, the GDP contribution of each industrial sector and their environmental loading were reviewed based on available data. Then, an estimation model could be built. An assessment of the future sustainability status was made possible by using the expected GDP growth in the local government's five-year-plan. The model could thus contribute to assessing and comparing alternative policies, for example, the impact of transforming economic structure from primary to tertiary industry.

In the view of the four-quadrant framework, the preliminary assessments mentioned above first focused on the upper right quadrant (i.e., aspects of exterior and individual) in studying the environmental facts of the Heihe River basin. Then, it moved downward to the bottom right quadrant (i.e., aspects of exterior and collective) in an expansion to management policy. If the research theme is placed at the center of the integral framework, the knowledge from the left quadrants, or "interior" aspects, regardless of individual or collective perspectives, were missing. In other words, the unit had been focusing only on the holistic view of interdisciplinary research on "exterior" aspects, which was conventionally quantifiable through the methodologies of traditional research disciplines. To bring in the elements of transdisciplinary research, the question to be answered was how the subjective view of individual and/or socio-cultural factors could respond to the proposed sustainability assessment.

The underlying concept of Planetary Boundary is based on the premise that humanity could face a high-risk of various types of ecological collapses if development transgresses nature's capacity to sustain it. The quantitative definition of the level of high-risk or boundary value must involve a normative value of human judgment (Dearing et al. 2014) that could not be solely answered in scientific terms. An example question would be, what percentage of land should be preserved as natural landscape to maintain the health of a regional ecosystem. Although we know the function of natural landscape in protecting biodiversity and regulating natural cycles, we are uncertain in quantifying such effect. The setting of boundary value must depend on collective local cultural judgments and values. Therefore, during the fieldwork in Zhangye a structured interview survey was conducted to examine the public perception on the sustainability of local ecosystem. Individual opinion was explored in two ways: how people perceived the changes in the environment with relation to the impact on their livelihood, and the urgency of different environmental risks. To do so, the members of the unit visited 21 villages and interviewed 58 residents along the middle reaches of Heihe River basin.

The results showed that a majority (79 %) of interviewees were concerned about the water scarcity impacting their livelihood, but did not agree regarding further deterioration on freshwater availability (22 % considered that reduction of river water would not take place in the future). One of the reasons given was that they had become aware of the water conservation effort by the government, and had a strong faith in the results of such policy. Examining the collection of individual interviews enriched the research with a sense of cultural or shared views by local community.

In short, the design of sustainability research of Oasis 2015 achieved a complete exploration of knowledge from all four quadrants, which is aligned with the Quadrvia approach. Its participants managed to contribute to a novel aspect to the Planetary Boundary, i.e., exploring the differences between people's perception and scientific determination of one regional ecological boundary.

4.2 Designing the Educational Program in Quadrants View

Akiyama and Li (2013) reviewed some of the learning outcomes from earlier Oasis Unit exercises carried out in the period from 2009 to 2012. These learning outcomes are described as competencies developed by students and are categorized depending on the quadrant most representative of each given competency. In brief, the results of Akiyama and Li (2013)'s study regarding the competencies developed by student are shown in Fig. 4.

Following the results presented by Akiyama and Li (2013), the authors have complemented the design analysis of the field exercise with the results obtained from the 2015 Oasis Unit. In terms of design analysis, the results are analyzed based on the activities carried out by the student during the 2015 Oasis Unit, and compared to the competencies found in 2013. The Oasis Unit can be decomposed into three chronological stages: pre-fieldwork (preliminary learning), fieldwork (on-site learning), and post-fieldwork (after-the-fact learning and joint task). At the moment of writing this chapter only the first two stages had been completed in their entirety, as shown in Table 1. Additionally, more time would be required to observe the development of competencies in the participants of the 2015 Oasis Unit. For these reasons, the results regarding the analysis of the field exercise design are presented as a preliminary case study in the present chapter. In spite of this limitation, the authors believe that the observations from the completion of the first two stages and the advancements on the third stage already present relevant information for the discussion of the design of the field exercise in 2015.

From Fig. 5 it is possible to appreciate how the activities carried out during Oasis Unit 2015 correlate well with the competencies developed by students from previous versions of this field exercise. It is important to bear in mind that the activities and competencies are expedientially classified into independent quadrants, but in reality they are interwoven and it is to be expected that activities mostly associated to one quadrant could have an effect on developing a

<p>Upper Left Quadrant <i>Subjective: Personal, Intentional</i></p> <ul style="list-style-type: none"> ▪ Finding personal vision ▪ Capacity to engage in self-reflection and introspection ▪ Increased self-awareness and emotional intelligence ▪ Increasing self-esteem ▪ Self-confidence and accountability 	<p>Upper Right Quadrant <i>Objective: Physical, Behavioral</i></p> <ul style="list-style-type: none"> ▪ Technical skills for independent research ▪ Facilitating communication ▪ Negotiating ▪ Decision making
<p>Lower Left Quadrant <i>Inter-Subjective: Cultural</i></p> <ul style="list-style-type: none"> ▪ Creating shared vision ▪ Valuing different perspectives ▪ Communication, listening, and interpersonal skills ▪ Observing and understanding the dynamics of different stakeholders ▪ Building trust 	<p>Lower Right Quadrant <i>Inter-Objective: Social, Systemic</i></p> <ul style="list-style-type: none"> ▪ Problem solving ▪ Building a network with resource persons ▪ Inclusion, listening and using all available ideas and skills ▪ Proactive information dissemination ▪ Bringing local voices into decision making

Fig. 4 Learning outcomes obtained from the Oasis Unit in the period 2009–2012

Table 1 The three stages of Oasis Unit 2015

Pre-fieldwork	Fieldwork	Post-Fieldwork
<ul style="list-style-type: none"> • Literature review • Group meetings • Presentation of research interest • Research proposal • Survey design • Environmental data collection and analysis • Coordination meetings with collaborating universities • Selection of group research 	<ul style="list-style-type: none"> • Visit to research center • Survey tests • Survey re-design • Interview design for city officials • Day-to-day individual tasks • Training of local students • Visit to 21 local villages • Survey to 58 villagers • Interview with city officials • Visit to water management related facilities • Visit to historical/cultural locations in the area • Research progress presentations 	<ul style="list-style-type: none"> • Post-fieldwork meetings • Transcription of recordings • Transcription of notes • Data analysis • Paper/report writing • Final presentation to collaborating universities and local government

competency mostly associated with another one. Further research is still required to verify the type of competencies developed by the students involved in the 2015 Oasis Unit, but at this point it is possible to demonstrate that the design of the unit allows for activities that enhance the student's experience in all four dimensions of the quadrants (Fig. 5). It is also interesting to note that for each quadrant there are activities that cover all three stages of the field exercise.

Upper Left Quadrant <i>Subjective: Personal, Intentional</i>		Upper Right Quadrant <i>Objective: Physical, Behavioral</i>	
Activities	Competencies	Activities	Competencies
<ul style="list-style-type: none"> ▪ Literature review ▪ Research proposal ▪ Day-to-day individual tasks ▪ Paper/Report writing 	<ul style="list-style-type: none"> ▪ Finding personal vision ▪ Capacity to engage in self-reflection and introspection ▪ Increased self-awareness and emotional intelligence ▪ Increasing self-esteem ▪ Self-confidence and accountability 	<ul style="list-style-type: none"> ▪ Presentation of research interest ▪ Training of local students ▪ Visit to 21 local villages ▪ Survey to 58 villagers ▪ Research progress presentations ▪ Interview with city officials ▪ Transcription of recordings ▪ Transcription of notes ▪ Data analysis 	<ul style="list-style-type: none"> ▪ Technical skills for independent research ▪ Facilitating communication ▪ Negotiating ▪ Decision making
<ul style="list-style-type: none"> ▪ Selection of group research ▪ Coordination meetings with collaborating universities ▪ Survey tests ▪ Visit to historical and cultural locations in the area ▪ Visit to research center ▪ Visit to water management related facilities ▪ Post-fieldwork meetings 	<ul style="list-style-type: none"> ▪ Creating shared vision ▪ Valuing different perspectives ▪ Communication, listening, and interpersonal skills ▪ Observing and understanding the dynamics of different stakeholders ▪ Building trust 	<ul style="list-style-type: none"> ▪ Survey design ▪ Group meetings ▪ Environmental data collection and analysis ▪ Survey re-design ▪ Interview design for city officials ▪ Final presentation to collaborating universities 	<ul style="list-style-type: none"> ▪ Problem solving ▪ Building a network with resource persons ▪ Inclusion, listening and using all available ideas and skills ▪ Proactive information dissemination ▪ Bringing local voices into decision making
Activities	Competencies	Activities	Competencies
Lower Left Quadrant <i>Inter-Subjective: Cultural</i>		Lower Right Quadrant <i>Inter-Objective: Social, Systemic</i>	

Fig. 5 A summary of activities in Oasis Unit 2015 and competencies found in 2009–2012 (An et al. 2011)

Since the field exercise is designed to address the issue of sustainability and it provides activities to ensure experiences in all four dimensions of the quadrant, it is expected that the competencies developed would be (at least in part, if not

entirely) those needed for sustainability researchers. This is an interesting thought that should be explored in future research to contribute to the discussion regarding the competencies required in sustainability science and the overall design of educational programs in this field.

5 Concluding Remarks: Integral Approach and Design of Oasis Unit

The Oasis Unit has been in constant development since its conception. Although the educational outcomes seem to be adequate and satisfactory so far, it is necessary to keep a critical perspective on the design of the field exercise to maintain this tendency and in order to ensure future improvement.

The strength of the integral approach lies in the fact that it provides a structured framework for the transdisciplinary research of complex sustainability issues, and decomposes the experiences of individuals into their four irreducible dimensions. In this way, it is possible for the designer(s) of the field exercise to understand the dimensions that the planned activities will affect the most, and consequently design an exercise that would allow the application of a range of diverse research methodologies and learning experiences with increasing depth and complexity in each dimension.

Because of its holistic nature, this approach can be especially challenging to implement or to be put into practice, since it does not provide clear steps for the design of a field exercise. Also, although it enables the designer(s) to check whether the planned activities could provide experiences in the four dimensions of the quadrant, it does not ensure that the outcome will be the same for all individuals. Given that the design of Oasis Unit considers the participation of students from diverse cultural and academic backgrounds, and despite the fact that they are all exposed to similar activities during the field exercise, the outcomes could vary greatly from student to student depending on their own personalities and idiosyncrasies.

The participation of other institutions during the field exercise is an opportunity for students to expand the range of their experiences, adding depth and complexity to the original design of the field exercise. Nonetheless, if the collaborating institutions are following a different approach this can result in a challenge to coordinate common activities in a way that does not hinder the original activities planned for the students. The coordination with other institutions and administrative tasks should not get in the way of the overall experience of the field exercise, unless of course they were planned as part of it from the beginning.

In conclusion, the true value of using an integral framework is that it is able to (1) map the research issue and methodologies in a holistic manner that is unique to sustainability science, and (2) design the educational program of a given field exercise. Compared to a conventional single problem focus fieldwork, it provides the cohesion for interdisciplinary scholars and transdisciplinary actors to come

together in an integrated framework. The four quadrants are irreducible. If a simplification of the situation was attempted by leaving out one or more perspectives, a fundamental aspect of the integral whole would be lost and the ability to understand and address it would be compromised.

This chapter supports most of the findings of the previous work carried out by Akiyama and Li (2013), though it adds new depth to the understanding of the application of Integral Approach to the design of field exercises. By analyzing the relation between activities and competences developed by students it is possible to understand the effect that experiences in each dimension of the quadrants have on their educational growth as sustainability researchers. Thus, the Integral Approach helps in the initial design of a field exercise as well as to when thinking about improvements of it, and it can significantly contribute to the discussion on relevant competences for sustainability researchers. The authors therefore suggest that field exercise practitioners apply the Integral Approach prior and after any research endeavor, for initial scanning and understanding of a given research problem and the design of activities and experiences on the field.

Acknowledgements A number of people have been part of the discussion for developing the field exercise unit conducted in the Heihe River basin. Especially highly acknowledged are the initiatives by Prof. Xin Li (Cold and Arid Regions Environment and Engineering Research Institute, Chinese Academy of Sciences), Prof. Mingguo Ma (Southwest University), Prof. Guangwei Huang (Sophia University), Prof. Takashi Mino, Prof. Eiji Yamaji, and Prof. Tomochika Tokunaga (The University of Tokyo) for the start-up of the field exercise unit. However, the authors take sole responsibility for any errors and the interpretation provided in this chapter.

References

- Akiyama, T., & Li, J. (2013). Environmental leadership education for tackling water environmental issues in arid regions. *Environmental leadership capacity building in higher education*, (pp. 81–92). Springer.
- Akiyama, T., Li, J., Kubota, J., Konagaya, Y. & Watanabe, M. (2012b). Perspectives on sustainability assessment: An integral approach to historical changes in social systems and water environment in the Ili River basin of Central Eurasia, 1900–2008. *World Futures*, 68(8): 595–627.
- Akiyama, T., Li, J., & Onuki, M. (2012a). Integral leadership education for sustainable development. *Journal of Integral Theory and Practice*, 7(3): 55–69.
- Akiyama, T., Li, J., Tokunaga, T., Onuki, M., An, K. J., Hoshiko, T., & Ikeda, I. (2010). Integral approach to environmental leadership education: An exploration in the Heihe River basin, Northwestern China. In: *Proceedings of the 8th international symposium on Southeast Asian water environment*, pp 40–49.
- An, K., Akiyama, T., Kim, J., Hoshiko, T., & Furumai, H. (2011). The influence of field-oriented environmental education on leadership development. *Procedia Social and Behavioral Sciences*, 15, 1271–1275.
- Brown, B. (2006). The use of an integral approach by UNDP's HIV/AIDS group as part of their global response to the HIV/AIDS epidemic. Retrieved 9 May 2010, from <http://www.integralworld.net/pdf/Brown.pdf>.

- Cole, M. J., Bailey, R. M., & New, M. G. (2014). Tracking sustainable development with a national barometer for South Africa using a downscaled “safe and just space” framework. *Proceedings of the National Academy of Sciences*, 111(42), E4399–E4408.
- Dearing, J. A., Wang, R., Zhang, K., Dyke, J. G., Haberl, H., Hossain, M. S., et al. (2014). Safe and just operating spaces for regional social-ecological systems. *Global Environmental Change*, 28, 227–238.
- Esbjörn-Hargens, S. (2005). Integral ecology: The what, who, and how of environmental phenomena. *World futures*, 61(1–2), 5–49.
- Fang, C.-L., Bao, C., & Huang, J.-C. (2007). Management implications to water resources constraint force on socio-economic system in rapid urbanization: A case study of the Hexi Corridor, NW China. *Water Resources Management*, 21(9), 1613–1633.
- Gidley, J. M., & Hampson, G. P. (2005). The evolution of futures in school education. *Futures*, 37(4), 255–271.
- Hochachka, G. (2008). Case studies in integral approaches in international development. *Journal of Integral Theory and Practice*, 3(2), 58–108.
- Inoue, M. (2007). Shindaiyouzeinenkan ni okeru Kokuga no danryu to kokugakinsuiseido ni tsuite. *Oasis chiiikishi ronsou (in Japanese)*. M. Inoue, Y. Kato & K. Moriya, 173–191.
- Kayane, I. (2008a). Reikoukojou to Tsuwano no hikaku kara kangaeta tourism no yakuwari (in Japanese). *Database of international center for Chinese studies*, Aichi: Aichi University.
- Kayane, I. (2008b). Environmental problems in modern china: Issues and outlook. *New challenges and perspectives of modern Chinese studies*, 265–285.
- Kayane, I., Miyazawa, T., & Zhu, A. (2006). Reikoukojou no mizu to shakai (in Japanese). *Water Sciences*, 291, 41–72.
- Lloyd, D. (2007). An integral approach to learning. *The International Journal of Environmental, Cultural Economic and Social Sustainability*, 2, 27–33.
- Olsson, L., Jerneck, A., Thoren, H., Persson, J., & O’Byrne, D. (2015). *Why resilience is unappealing to social science: Theoretical and empirical investigations of the scientific use of resilience*.
- Pirages, D. (2000). Pillar of sand: Can the irrigation miracle last? *Perspectives on Political Science*, 29(2), 121.
- Rockstrom, J., Steffen, W., Noone, K., Persson, A., Chapin, F. S., Lambin, E. F., et al. (2009). A safe operating space for humanity. *Nature*, 461(7263), 472–475.
- Shiklomanov, I. A. (2000). Appraisal and assessment of world water resources. *Water International*, 25(1), 11–32.
- Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., et al. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, 347(6223).
- Wiek, A., Withycombe, L., & Redman, C. (2011). Key competencies in sustainability: A reference framework for academic program development. *Sustainability Science*, 6(2), 203–218.
- Wilber, K. (2001). *A theory of everything: An integral vision for business, politics, science, and spirituality*. Shambhala publications.

Sustainability Science: Field Methods and Exercises

Esteban, M.; Akiyama, T.; Chiahsin, C.; Ikeda, I.; Mino, T.
(Eds.)

2016, VIII, 243 p. 52 illus., 25 illus. in color., Hardcover

ISBN: 978-3-319-32929-1