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Exercise on Transdisciplinarity: Lessons from a Field-Based Course on Rural Sustainability in an Aging Society

Shogo Kudo [1,*], Huma Mursaleen [1], Barry Ness [2] and Masafumi Nagao [3]

[1] Graduate Program in Sustainability Science—Global Leadership Initiative (GPSS-GLI), Graduate School of Frontier Sciences (GSFS), The University of Tokyo, Kashiwa 277-8563, Japan; mursaleen@s.k.u-tokyo.ac.jp

[2] Lund University Centre for Sustainability Studies (LUCSUS), Lund University, SE-222 70 Lund, Sweden; barry.ness@lucsus.lu.se

[3] United Nations University—Institute for the Advanced Study of Sustainability (UNU-IAS), United Nations University, Tokyo 150-8925, Japan; nagaom@unu.edu

* Correspondence: kudo@edu.k.u-tokyo.ac.jp

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Abstract: Sustainability science emerged as a new academic field to address complex sustainability challenges. To train sustainability experts, sustainability science programs and sustainability-focused courses are offered in higher education, especially at the graduate level. Given the diverse topics and the complex structures of sustainability challenges, what are the required knowledge and skills needed for sustainability experts? Although the earlier literature identified key features and competencies, empirical studies on how educational programs in sustainability science provide the necessary training are still scarce. This study addresses this gap by illustrating how a field-based course can contribute in developing core skills for fostering sustainability experts through a case study of field-based course called Global Field Exercise (GFE) in the Graduate Program in Sustainability Science-Global Leadership Initiative (GPSS-GLI) at The University of Tokyo. Literature review on the competencies in sustainability science suggests a three-way typology of descriptive-analytical skills, solution-oriented skills, and attitudinal skills. A group of students joined a GFE unit in Akita, Japan, and set "local food and place attachment" as the topic for their fieldwork. The participants conducted semi-structured interviews to three generational groups to illustrate the different perceptions of local food and places. The alternative mechanism of knowledge transmission across generations by local festivals and school events was found. The authors observed the implemented field-based course provided unique learning opportunities to acquire: (i) the ability to perform key competencies collectively instead of individually; (ii) an interdisciplinary-mindset to acknowledge multiple views to topics during group discussions among researchers; (iii) a transdisciplinary-mindset to communicate research outputs with local residents in a communicable way; (iv) the ability to be empathetic to people's experiences when addressing normative dimensions of sustainability. Although different sets of competencies and approaches for fostering sustainability experts have been studied widely, the field-based approach plays an important role in developing transdisciplinary, interpersonal, and normative competences.

Keywords: sustainability science; field-based education; competencies; aging society; local food; interdisciplinary-mindset; transdisciplinary-mindset; empathetic competence

1. Introduction

Sustainability science emerged in the early 2000s as academic field to address sustainability challenges. The field aims to advance understanding on the dynamic interactions between nature and society [1–3], and facilitate normative discussions on sustainability by critically inquiring how a sustainable society can be envisioned [4]. Integration of knowledge from different academic fields (interdisciplinary approach) and co-creation of knowledge with social actors (transdisciplinary approach) are identified as the key features of sustainability science [5–7].

Given the diverse topics and the embedded complex structures of sustainability challenges, what are the required knowledge and skills needed for sustainability experts? Competence based educational development is supported by the earlier literature. Competence is a comprehensive concept to describe one's ability in understanding complex problems, analyze problem structures, and perform problem-solving skills [8]. Shift from knowledge-based education to competence-based education is claimed necessary for responding to sustainability challenges [9–12].

Although the key features and core competencies in sustainability science have been identified, empirical studies on how educational programs in sustainability science provide the required knowledge and skills to students are still scarce. Reflecting the convergence of knowledge from multiple disciplines and social actors by interdisciplinary and transdisciplinary approaches, new forms of teaching and learning that create dialogues with diverse stakeholder groups needs to be explored. However, earlier studies are limited to framework development (e.g., Lang et al., 2012 [13]), structural assessment of fieldwork-based courses [14], and region-specific review of sustainability-focused courses in higher education [15].

This study aims to fill this gap in sustainability science education literature by illustrating the identified core competencies and actual trainings being offered by a sustainability science program. This is done by discussing core skills for sustainability experts by reporting a case of field-based course training called Global Field Exercise (GFE) offered by the Graduate Program in Sustainability Science-Global Leadership Initiative (GPSS-GLI) at The University of Tokyo. Based on the observation during one of the GFE units held in Akita, Japan, the authors elaborate their insights on how a sustainability science program can offer necessary trainings to train particular mindsets required for transdisciplinary project.

2. Literature Review: Competence Discussion in Sustainability Science Education

In the literature of sustainability science education, the work of Wiek and colleagues [16] is considered as a cornerstone where they identified five key competencies in sustainability science. They suggested an integrated problem-solving framework for sustainability research. In this framework, a broad picture of sustainability science research is illustrated in four steps: (i) identifying a complex problem in society; (ii) examining possible intervention points to create a sustainability vision; (iii) anticipating how the situation may evolve if the problem is un-intervened; and (iv) exploring sustainability transition strategies. The five competences are identified to plan, conduct, and engage in problem-solving processes; those five key competencies are system thinking, anticipatory, normative, strategic, and interpersonal competencies [16].

Similarly, other studies followed the intention to train competencies in sustainability education. Dedeurwaerdere [17] argues that complex-system thinking and experiential learning in multi-stakeholder interaction are required to train students to analyze complex structure of sustainability challenges [17]. Hidalgo and Fuentes [18] emphasize cognitive, methodological, and attitudinal competencies. The cognitive competence is about knowledge and critical understanding of multiple scales in environmental and social issues. The methodological competencies are abilities to acquire knowledge, skills, and strategies for sustainable development. Lastly, the attitudinal competencies are related to the evaluation of attitudes and values towards sustainability [18].

In the work of Tamura and Uegaki [19], sustainability education is elaborated as a broad structural reform within society rather than an individual awareness reform. They stress behavioral

knowledge education, on-site learning, and experience of actual problems. In addition to the skills mentioned by other studies (e.g., interpersonal skills, holistic and basic knowledge accumulation, and problem-solving skills), they argue that mental strength such as the motivation to work on a problem, acceptance to diverse opinions and beliefs, and synchronic and diachronic consciousness are critical competences of sustainability experts [19]. Moreover, Perez Salgado et al. [20] investigate professional competencies of sustainability experts through two workshops. They identified intervention competence that entails seven key dimensions of sustainability experts. The ability to engage with different perspectives of diverse stakeholder groups is identified as one of the key dimensions [20].

The competencies discussed in earlier literature can be summarized in a three-way typology of: (i) *descriptive-analytical skills* to illustrate the complex structure of sustainability challenges; (ii) *solution-oriented skills* to choose or combine methods to address the problem; and (iii) *attitudinal skills* to incorporate normative discussions on sustainability. These three types of skills are interlinked and necessary both for sustainability science *research* and sustainability science *practice*. However, the weight of descriptive-analytical skills and solution-oriented skills are much heavier for research, while that of attitudinal skills is more critical for practice. Sustainability experts must apply these skills in a reflexive way to deliver concrete changes for sustainability transformation in different contexts [18].

Elaborating on the earlier literature on the competences, sustainability science programs must reflect these three types of skills by applying new forms of teaching and training such as field-based education. The field-based course introduced in this study is an attempt to train participants' performance especially for sustainability science practice.

3. Methods for Data Collection and Assessment

This study employs case study approach to illustrate how a field-based course can contribute in developing core skills for fostering sustainability experts. The methods to record and assess the performed competencies of the course participants were: (i) observation of fieldwork activities; (ii) individual consultations with participant; and (iii) discussions among the unit organizers, during the unit implementation. Because each unit organizer had different observations and consultations, they recorded their findings on the participants' performance of core skills on their fieldwork notes.

The unit organizers had reflection sessions on a regular basis during the unit, at the most frequent case per interview the participants had, to share and discuss their findings. Those discussed points both during and after the unit implementation were also recorded in authors' fieldwork notes. Additionally, follow-up individual meetings were conducted to collect the participants' reflections and learning achievement. The overall course assessment was done by a separate follow-up meeting among the unit organizers. The suggested three-way typology of core skills was applied when the collected discussion points were analyzed by the authors.

4. Case Study: Field-Based Exercise of Transdisciplinary Approach

Field-based education or problem-based learning is commonly applied in environmental studies; it is a prominent way to provide training for students to acquire key competencies for sustainability research [21–23]. Graduate Program in Sustainability Science—Global Leadership Initiative (GPSS-GLI) of The University of Tokyo has offered a postgraduate program in sustainability science since 2012, and field-based education has been the core component of the program curriculum. GPSS-GLI started its Master's degree program in 2002, and later PhD degree program developed in 2005. Course participants are exposed to diverse topics in the locations where actual sustainability challenges exist; they learn the process to form research questions, design fieldwork activities, and formulate a workable project within the set time of the course [23]. The following section describes one of the GFE units conducted in Akita, Japan (hereafter GFE Akita) as a case study of how field-based course is organized as an exercise on transdisciplinary approach.

4.1. Context of GFE Akita: Rural Sustainability Challenges in an Aging Society

GFE Akita set rural sustainability in an aging society as the overarching unit theme. Akita is experiencing the most rapid aging and shrinking of population in Japan. The total population of Akita is approximately 1.02 million people and the proportion of residents who aged 65 and above is 33.8 percent in 2016 [24]. This ratio of population aged 65 and above is 6.5 percent higher than the national average. Simultaneously, Akita is experiencing continual out-migration of young people. Akita experienced −5.8 percent of population growth between two national census in 2010 and 2015; this is equivalent to a decline of 10,000 people every year since 2010.

Gojome town in Akita was selected as the town to conduct course activities; it is a representative small-size municipality where a variety of rural challenges have emerged due to aging and shrinking of population. Additionally, the authors have been conducting research and outreach activities in the town the last four years, therefore having familiarity with local contexts.

Figure 1 shows the location of Gojome. The town has approximately 9200 residents and the proportion of population aged 65 and above is 42.4 percent as of October 2016 ("Gojome Population Vision" available from the website of Gojome Town Government (http://cms.town.gojome.akita.jp/pdf/bijon.pdf)). Figure 2 shows population changes of Gojome from 1965 to 2015, and population predictions until 2040. In 1965, the total population was approximately 18,000 people. The town has been experiencing continual population decline since 1965, and in 2015 the total population was 9433 people, about 50 percent of the total population size of 1965. Subsequently, the share of youth population (age 0 to 15) declined over time: it was around 20 percent in 1980 but it was only 7.9 percent in 2015.

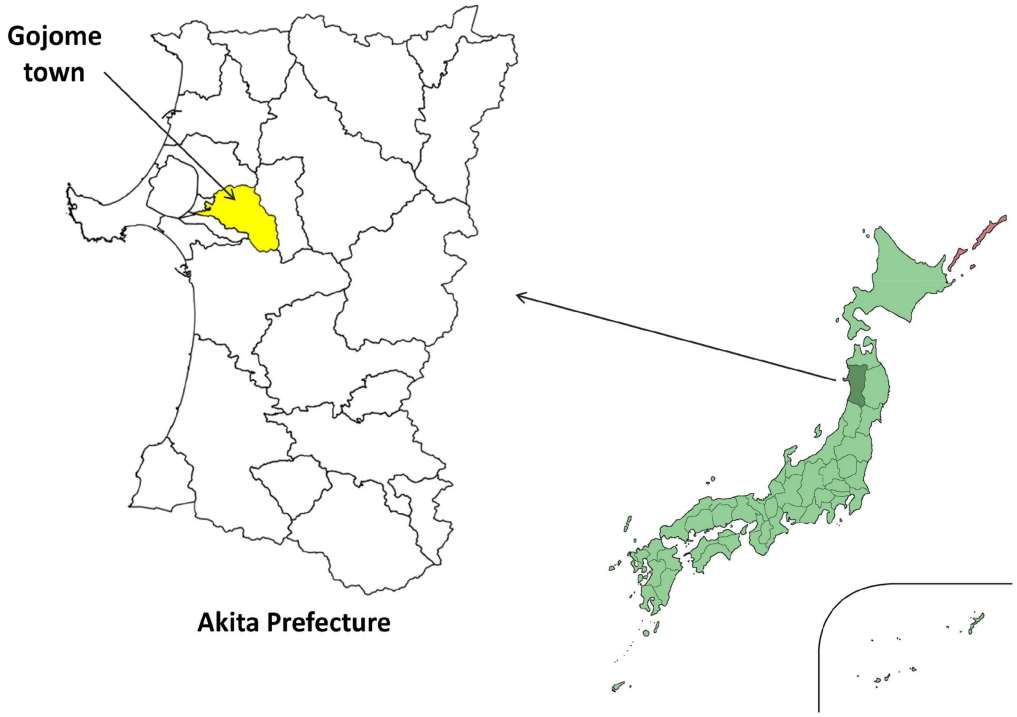

Figure 1. Location of Gojome town in Akita prefecture, Japan (created by the authors).

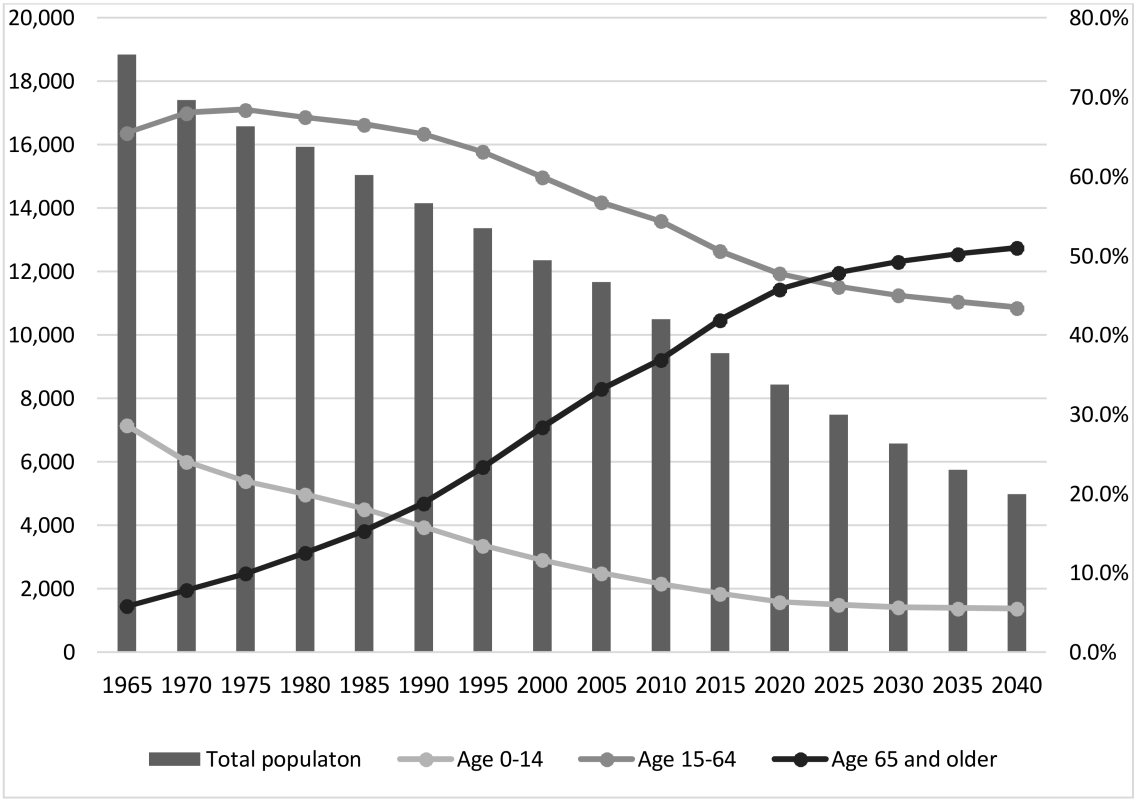

Figure 2. Population change of Gojome town since 1965 (data source: Gojome Town Population Vision, 2016).

Combined demographic changes of aging and shrinking population cause various challenges related to rural sustainability. One notable challenge is about managing physical assets such as agricultural fields, community forests, and individual houses due to the aging of residents and lack of younger successors [25–29]. The out-migration of the young population has been a major cause of these challenges. The insufficient number of younger residents creates a challenge in sustaining traditional knowledge that plays an important role in farming practices, disaster preparedness, and local identity formation [30,31]. Due to the demand decline in the local market, maintaining services both by private and public sectors is becoming financially difficult. Whether one can drive a car or not determines the quality of mobility because public transportation services have been withdrawn from mountainous areas [32,33].

4.2. Unit Fieldwork Design

GFE Akita unit was organized in February 2017 and 12 students from three universities formed a joint team. The team consisted of three groups of students, nine students from The University of Tokyo, two students from Lund University (Sweden), and one student from Akita International University (local university in Akita City). Preparatory meetings were organized to: (i) study societal transformations in Akita; (ii) set a topic for field surveys; and (iii) plan fieldwork activities. The team set "place attachment" as a concept to explore through the fieldwork. This is because understanding the psychological connection between the location and the residents is considered as a critical factor for rural sustainability. Because place attachment is an abstract concept to investigate, "local food" was set as a concrete topic to form questions for surveys. The processes of preparing ingredients, cooking, and serving local food is well linked with traditional culture, knowledge, and family structures of locality that contribute to people's sense of place attachment.

"Place attachment and local food" has a great relevance to sustainability for two reasons. The first reason is its etymological meaning; sustainability means to "up-hold" a state of a given condition (the word "sustain" comes from Latin *sustinere* (hold up, hold upright)). Some may misinterpret sustainability is dominantly about environment while this is not the case as sustainability includes a wide range of topics as presented in the Sustainable Development Goals (SDGs include goals related to socio-economic development such as "Quality Education", "Gender Equity", "Reduce Inequalities"). The current sustainable development discourse aims at enhancing well-being of humans while keeping human activities within the "safe operating zone" [34]. In rural context, sustaining psychological attachment to place and associated knowledge of local food convey key values for the sustainability of local communities.

The second reason is supported by Anthony Giddens's explanation on the "reproduction of activity" [35]. The current sustainable development discourse touches upon socio-economic topics such as global health, poverty and inequality, and gender in relation to sustainability. Reproducing practices which ensure well-being related needs and social values is equally important for sustainability. The set topic for GFE Akita unit, place attachment and local food, is highly relevant topic when discussing reproduction of social values and lifestyles of people which have already been established as sustainable human–nature relationship through integrating the intergenerational knowledge transfer of traditional knowledge in a given locality.

This study addresses the issue of sustaining traditional knowledge on local food through the case study of an aging and shrinking rural town in Japan. More specifically, the team decided to investigate the mechanism of knowledge transfer on local food across different generation groups. To illustrate the difference among age groups, the team planned to conduct interviews, targeting three resident groups, namely youth (elementary, junior-high, and high school students), middle-aged residents (late-20s to 50s), and elderly residents (65 and older).

4.3. Unit Implementation

Fieldwork started with two-day excursion of Gojome town. Geographically, the town consisted of the central area where shops, clinics, and all public facilities including schools are located, and the in-land area where farming-based communities exist in mixed landscape of paddy fields and forest. The team started the excursion in *Koiji* community located in the in-land area. They walked around the community to observe typical living conditions in *Koiji* during winter. In the central area, the students visited the farmers' market called "*Asaichi (farmers' market)*" open four to five times a month. At this market, residents from Gojome and neighboring towns sell locally produced vegetables, preserved food, and local dishes. The team had informal interviews with those who were selling locally produced items at the market (Figure 3).

Figure 3. Field excursion in Gojome town: (**left**) library room in Gojome community center; (**center**) Asaichi (farmers' market); and (**right**) Koiji community in in-land area of Gojome.

From the third day, the team conducted semi-structured interviews in various forms such as individual interviews, group discussions, and interviews during cooking lesson, to the three resident groups (see the list of questions for interviews in the Appendix A (1)). These different formats were

adopted to make the interview setting comfortable for informants, especially the one with elderly group during a cooking lesson was effective to retrieve stories about local food (Figure 4).

Figure 4. Interview surveys in three age groups: (**left**) group interview at Gojome High School (youth group); (**center**) interview with a local resident (middle-age group); and (**right**) learning how to cook local dishes (elderly group).

The youth group organized their interviews differently from the other two groups because of the limited experience of local food of their informants. They visited three local schools in the town and organized group discussions. Students were asked to name the type of food or dish they consider traditional or typical in Gojome and provide reasons why they gave those answers. Follow-up interviews were conducted to home economics teachers and school cooks to learn school's lunch program. In both schools, "*chisan-chisho (locally produced and locally consumed)*" is the key principle of their lunch programs. School cooks said that they believe informing that students are consuming locally produced food through lunch program helps student nurture sense of attachment to local areas. The home economics teacher of Gojome Junior High School issues newsletter monthly to inform students and parents about the *chisan-chisho* lunch program at school.

4.4. Outputs: Reporting Exhibition to Local Residents

The outputs of fieldwork were presented as a public exhibition (Figure 5). The exhibition format enabled the audience to see the primary data collected in interview surveys, and this step allowed them to ponder their own ways of interpreting the results along with the presented analysis by the team. The exhibition presented: (i) types of local food considered traditional or typical; (ii) analysis on intergenerational knowledge transmission across generations; and (iii) reflections from the audience.

Figure 5. Reporting exhibition of findings at a local art gallery in Gojome.

To introduce the exhibition, types of local food that different generational groups considered traditional or typical were presented through pictures and direct quotations from interviewees. Various types of food were mentioned by different age groups such as *Damakonabe* (soy sauce flavored chicken soup with small rice balls and vegetables), *Hatahata-zushi* (preserved dish of *Hatahata* fish being marinated with rice, rice malt, turnips, carrots, and seaweed), different kinds of *Tsukemono* (vegetables pickled in salt for preservation), and *Oyaki* (round-shape rice cake with sweet soybean paste inside).

One informant at the middle-age group mentioned that one key feature of local food is that we always eat it with your family, friends, or your neighbors; we never eat local food alone. He elaborated that local food creates social ties or connections with others in local areas including its cooking process. The other informant in the middle-age group, a mother of three daughters, responded to one question on the knowledge transmission of local food by saying that she is not much worried about teaching her daughters how to cook local dishes. What she described was that, as long as she serves local dishes to them frequently, they will remember the taste of those dishes. One day when her daughters form their own families and hope to cook those local dishes from the town, her daughters may not know the exact ways to cook but they will remember which tastes they need to adjust when they are cooking. Additionally, she described that local dishes, especially *Damakonabe*, are something they cook to welcome those out-migrated family members when they return to home during summer or winter holiday. She explained that local dishes generate a strong sense of home by this way.

The other person from the elderly group explained that local dishes are something they enjoy cooking together with their friends in same age group. Especially those preserved food (e.g., *Tsukemono* of various vegetables and *Hatahata-zushi*) have different taste depending on who cooks them. The elderly resident group mentioned that they enjoy exchanging their dishes and teaching cooking techniques to each other. Another elderly person mentioned that in one family each generation has different food preferences. She prefers traditional way of cooking with more fish and vegetables while her grandchildren prefer processed food with stronger taste. She thinks this difference in food preference is somewhat inevitable because more varieties of food are available today. However, she expressed her hope that the local dishes people in Gojome have prepared at the occasions of traditional events will continue to be learned by younger generation because local dishes are linked with the local beliefs in each area.

At the second section of exhibition, the team presented the analysis of their findings visually (see infographic created for this visualization in Appendix A (2) Figure A1). The conventional way of knowledge transmission on local food was sequential across three generational groups; grandparent generation taught parent generation, and the same teaching happened between the parent generation and child generation. However, today, the parent generation is preoccupied with work and it is becoming more and more difficult for them to learn how to cook traditional dishes from older generations and also to teach the younger generations. The team identified a different mechanism of knowledge transmission which works through local festivals and school events where a group of elderly residents cook and serve traditional dishes. By this way, the local youth, especially elementary school and junior-high school students, learn local food. In the interviews with school cooks and teachers, they described that those children who learn local food at festivals and school events talk about their experiences to their parents and grandparents at home. By these conversations in each household, older generations become motivated to learn and teach how to cook traditional food. This new mechanism is driven by external events to each family, however later it generates conversations about children's experience and assures knowledge transmission on local food.

The team found that the new way of knowledge transmission is supported by perception to natural environment and changing lifestyle. Throughout the interviews, particularly with elderly residents, the team realized the way residents understand natural environment differs among generational groups. This is largely because the elderly residents have rich experience in farming activities from their childhood. They are also more familiar with picking wild vegetables in local forest. In contrast, the middle-age and youth generation residents have either a limited experience or no experience in direct engagement with nature. This lack of direct connections with local environment from different perception to natural environment.

Linked with the different perceptions to natural environment, lifestyle of middle age resident is largely different from that of older residents. This is evident as many of them commute to outside of Gojome town and work in the service industry. Therefore, vegetables and other food are, in general, something to purchase form supermarkets for the middle-age residents, whereas the older residents

grew up with the mindset of purchasing the items only they cannot produce in their own farms or cannot get from exchanges with neighbors. These different ways of lifestyle are likely to be reflected in their answers about local food.

The third section of exhibition was designed for collecting feedback from the audience. Around 30 people, mostly those who participated in interviews, gathered at the exhibition. The reporting was well received and most of the informants said that participating interviews and seeing the exhibition made them reexamine their culture related to local food. The team members discussed with some audience on the relationship between local food and place attachment. One informant in the middle-age group, school nutritionist, said that she feels a stronger sense of connection with local farmers and farmlands when she is involved in *chisan-chisho* (locally produced and locally consumed) initiative through the school's lunch program. She added that students in elementary and junior-high school student have a chance to feel the same way of place attachment through school lunch program, however it may be difficult for high school students because they are not exposed to *chisan-chisho* lunch programs. The team also had a conversation with another middle-age resident and he explained that the knowledge of wild vegetables is well linked with the sense of place in local areas because there are some spots we can find more varieties. He is concerned about learning the knowledge about wild vegetables from his grandparent generation now, otherwise it would be lost. The exhibition session provided an opportunity for the local residents to exchange ideas on how to sustain local knowledge associated with food and places.

5. Analysis and Discussion

During the implementation of GFE Akita, the authors observed several occasions that the participants performed specific types of skills that helped the team remain productive in group discussions, analyze the collected data, and decide how to deliver their findings to the local community. The three-way typology of: (i) descriptive-analytical skills; (ii) solution-oriented skills; and (iii) attitudinal skills, based on the literature review of this study was applied to analyze the performed skills during the field-based course.

5.1. Performing Competencies Collectively

The applied unit of analysis in earlier literature on competence is individual, however, the participants of GFE Akita performed some competencies better when they worked as group, for example, systems thinking. Drawing a system requires setting system boundaries and identifying cause and effect relationships among the identified factors. The steps of drawing a system are performed better when the subject system is examined collectively. This was particularly the case in GFE Akita because the local context was new to all members, a language barrier to the majority of the participants existed, and the amount and quality of information obtained from each interview were different among the members because of their different academic backgrounds. When analyzing the collected data, participants supplemented information to each other and discussed possible links among the identified factors that they found from each interview. Those non-Japanese speaking members, because they need to retrieve secondary or additional information through translations, constantly raised questions for clarifications. This step helped them verify the identified cause and effect relationships. Anticipatory competence is another example of collective performance of competence. Developing possible scenarios was performed better when the process was facilitated by one member who is more knowledgeable about the discussed topic. Hence, the participants took turns in the facilitator role depending on who obtained clearer understanding.

These points suggest that interpersonal competence has a primary importance when conducting a transdisciplinary project. Perez Salgado et al. [20] also informed the ability to engage with diverse perspectives as one of the key competencies of sustainability professionals [20]. During GFE Akita unit, the authors observed that some competencies (e.g., systems thinking and anticipatory) can be supplemented and strengthened among the participants. Such collective performance of competencies raises an important question to educational programs in sustainability science: whether a program

curriculum should be designed to offer trainings of all key competencies at individual level or to train students to be able to retrieve others' competencies. A short field-based course (a week to 10 days training) such as GFE Akita suites to train collective performance of key competencies.

5.2. Interdisciplinary-Mindset

Throughout the unit from preparatory meetings to fieldwork, there were many occasions that the participants had different opinions on how to structure the activities, interpret the data, and present their findings. On the one hand, they had to negotiate to each other and such communication among the members generated vibrant atmosphere in group discussions. On the other hand, the authors also observed some occasions that only one or two members dominate the conversation and those who disagree with the discussion decided to stay quiet. Such situation seemed to be caused by the difference in academic and thematic interests of members. Moreover, the different understanding on the role of sustainability science either in describing complex challenges or action-oriented approach appeared as different emphasis; some members preferred spending more time on critically appraising and analyzing the current state while others preferred pitching ideas for concrete actions they can propose to local communities. These two are equally important dimensions of sustainability science because sustainability challenges require both long-term strategies based on comprehensive understanding on the embedded complexity as well as short-term, immediate reactions as "solutions to problems may have to be sought before those problems are sufficiently analyzed or identified" [36]. One strength of field-based course is to be able to offer experiential learning on how to consider this balance between critical research and action-oriented nature of sustainability science.

Being interdisciplinary requires researchers to hold multiple disciplinary bases or at least awareness on different ontological and epistemological perspectives when collaborating with others from different academic backgrounds. Such interdisciplinary-mindset to acknowledge multiple views to the reality is essential to perform *descriptive-analytical skills* to examine the complex sustainability challenges, however this appeared as one major challenge. By observing three groups, one critical condition that differentiated a group to remain productive or not was the presence of member who is able to step back from the discussion, re-organize the discussion points, and suggest an alternative framing to examine the topic. The ability to observe ongoing discussions from a meta perspective enabled one group to keep interdisciplinary-mind. One major advantage of field-based course is to be able to provide the opportunities to consciously perform such interdisciplinary-mindset in a concrete case setting. Unit organizers are required to have skills to design a course in such a way as both time for getting into the discussions on the set topic and the time to come back to a meta perspective to reflect the participants' engagements both individually and collectively. In contrast, one learning that a short field-based course cannot offer is a lesson from failure. Given the limited time in the field, one course cannot embrace a communication failure in group work although the amount of learning participants gain may become larger if they are successful in restructuring their communication.

5.3. Transdisciplinary-Mindset

Sustainability science emphasizes transdisciplinary approach in which researchers and social actors co-create knowledge and co-design actions to guide society to sustainability. The transdisciplinary idea implies a new mindset that goes beyond the academic and non-academic divide and this requires researchers more efforts than avoiding jargons and rephrasing research outputs. Transdisciplinary-mindset entails an entire package of communication with non-academic actors from team formation, planning of joint activities, and actual implementation of projects [13,37]. This is critical when performing *solution-oriented skills* to choose or combine methods to address sustainability challenges.

How then can a sustainability science program offer a training of transdisciplinary-mindset? One concrete starting point is the suggestion by Clark and his colleagues that researchers should produce more usable knowledge for sustainability [38]. Delivering the research finding is the primary step for sharing of usable knowledge to co-envision the future. Field-based courses provide

opportunities to practice how to deliver research outputs in a communicable and interactive ways to different types of audience. The exhibition session in GFE Akita generated a momentum between the participants and local residents and served as a venue to exchange ideas on the possible future states of the town in terms of local food and place attachment. This process in GFE Akita was effective training for the participants not only to communicate their fieldwork outputs with non-academics but also to learn how to build a trust with local residents. This is critical step when aiming for co-envisioning of a sustainable future.

One limitation of field-based course that the unit organizers must be aware of is that the conduct of such course is often at the cost of the receiving community. Because of the time, resource, and other constraints, the course participants can seldom form a team with local actors and co-design and co-implement activities. Hence, a short-term field-based course like GFE Akita can only serve as a practice on how to engage with local community. One possible way to overcome such deficiency is that the course organizers aim at the cumulative impact of multi-year course implementations, for which the receiving community may become a co-organizing partner from the course design phase.

5.4. Ability to Be Empathetic to People's Personal Experiences

One major learning process in a field-based course occurs when the normative dimension of sustainability is addressed. *Attitudinal skills* are required to examine fundamental questions of sustainability: (i) sustain what; (ii) sustain for whom; (iii) sustain how long; and (iv) sustain at what cost (Tainter 2003); and additional meta level question of (v) who is eligible to answer these four questions. GFE Akita is designed specifically to address the meaning of sustainability in the context of aging and shrinking society where economic, political, and sociocultural activities have been downscaling. In this context, the meaning of sustainability becomes increasingly unclear, identifying how local residents perceive sustainability and envision their future is an essential step that researchers must address.

To approach the normative dimension of sustainability, the ability to be empathetic to people's personal experience is critically important. This is because sustainability is fundamentally a subjective notion and sustainability experts must be reflexive to diverse interpretations of sustainability. The ability to be empathetic allows researchers to understand people's value orientation, see the world from the other's point of view, and identify how sustainability is perceived in a specific context. Lack of such ability would result in misinterpretations of what are key elements of sustainability to different stakeholder groups. One main finding of GFE Akita fieldwork is that knowledge transmission on local food across three generational groups is ensured by a new mechanism through local events and school activates. Behind this finding, there were many conversations during the interviews that the informants expressed their ideas, thoughts, and feelings based on their personal experiences. The participants performed empathetic competence to imagine what the discussed topics mean to each informant. Field-based course offers substantive learning to obtain empathetic competence through experiencing people's lifestyle in a particular locality.

6. Conclusions

This study illustrates how a field-based course contributes to foster sustainability experts through a case study of field-based course, Global Field Exercise in Akita (GFE Akita), in the Graduate Program in Sustainability Science—Global Leadership Initiative (GPSS-GLI) at The University of Tokyo. The literature review of this study suggests the three-way typology of core skills of sustainability experts: (i) descriptive-analytical skills; (ii) solution-oriented skills; and (iii) attitudinal skills. A group of students joined GFE Akita which set rural sustainability in an aging and shrinking society as its overarching theme. The specific topic for the fieldwork was "local food and place attachment." Semi-structured interviews to three generational groups were conducted to depict the different perceptions to local food and place attachment. Instead of the sequential way of knowledge transmission across three generational groups, the alternative mechanism of knowledge transmission through local festivals and school events was found.

Based on the observation, individual interviews, and discussions among the unit conveyors, this study suggests that the field-based course provides training on: (i) collective performance of key competencies; (ii) an interdisciplinary-mindset to acknowledge multiple perspectives when conducting a research; (iii) a transdisciplinary-mindset to communicate research outputs with non-academics and initiate co-envision of the future; and (iv) empathetic competence to address normative dimension of sustainability based on other people's worldview. Educational programs in sustainability science can benefit from field-based courses in developing transdisciplinary, interpersonal, and normative competences.

The current study concentrates on describing the case of GFE Akita unit and elaborating discussions based on the unit organizers' perspective. It is necessary to combine multiple perspectives to fully assess the effectiveness of field-based courses in nurturing the core skills for sustainability experts. Further studies are necessary to identify what pedagogical approaches are effective, what thematic and contextual settings are desirable, and how to collaborate with the residents of local communities even though the courses are primarily for educational purpose. Comparative assessment studies among sustainability science programs in higher education, especially focusing on various forms field-oriented courses, would be highly beneficial for the programs to better incorporate exercises on transdisciplinarity in sustainability science education.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

1. Below is the list of questions asked during the semi-structured interviews to the middle-age and the elderly resident groups. The collected answers in each group were combined to analyze the knowledge transmission on local food and sense of place in Gojome.

    (1) What kind of food do you consider as traditional or typical food?
    (2) Why do you consider those food as traditional?
    (3) Have you been taught how to cook these dishes from your family?
    (4) What kind of food did you eat during your childhood?
    (5) Who prepared it including collecting ingredients?
    (6) Growing up, did you learn to cook the food from your childhood? Who taught you?
    (7) Have you transferred your knowledge on cooking to your children?
    (8) What kind of local food are you proud to present to visitors from outside the region?
    (9) What kind of food do you miss when you are away from the region?
    (10) How do you view the future of the local food?

2. Below is the visualization done by the participant group to illustrate the alternative ways for knowledge transmission across different age groups. This infographic was presented as the summary image of the fieldwork at the reporting exhibition in Gojome.

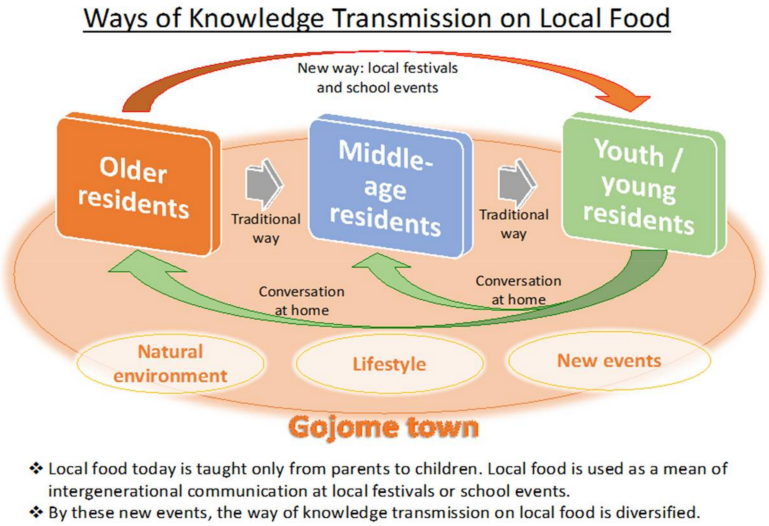

Figure A1. Alternative way of knowledge transmission on local food.

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