



Integrating sustainability themes for enhancing interdisciplinarity: a case study of a comprehensive research university in Japan

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Abstract

Interdisciplinary education and education for sustainable development provide a complementary approach to enhancing learners' interdisciplinary and sustainability competencies. An interdisciplinary approach is considered a crucial method for enhancing university students' competencies in sustainability. However, the use of integrating sustainability issues for the purpose of enhancing interdisciplinary education in universities is still under investigation. In contrast to the analyses of sustainability studies programs, this case study explores how sustainability issues could enhance interdisciplinarity in teaching and learning in non-environmentally related courses that do not have special learning objectives related to sustainability. By borrowing Biggs' comprehensive model of teaching and learning in higher education, this case study analyzes an undergraduate general education course and a postgraduate course at a comprehensive research university in Japan from four perspectives: students' perspectives learning environment, learning process, and learning outcomes. This qualitative case study data were collected through mixed research methods, including questionnaires and semi-structured interviews with instructors and learners. Findings demonstrate that interdisciplinary teaching and learning can be enhanced by integrating sustainability issues into non-environmentally related courses. By integrating sustainability issues into the curriculum, students and instructors from various disciplines can collaborate with the intention of enhancing students' abilities to integrate knowledge and communicate with people from different backgrounds and experiences. The paper concludes by discussing the achievements of and barriers to incorporating sustainability themes into interdisciplinary teaching and learning in non-environmentally related courses at universities. Moreover, it provides implications of utilizing a complementary relationship between sustainability and interdisciplinarity to innovate and rethink teaching and learning in higher education to prepare students to build a sustainable future.

Keywords Sustainability · Interdisciplinarity · Non-environmentally related course · Teaching and learning · University · Japan

Introduction

Higher education has been widely considered one of the major players in achieving the United Nation's Sustainable Development Goals (SDGs) (Leal Filho et al., 2019; Tilbury, 2011). Higher education institutions (HEIs) have a significant role in contributing to the SDGs through education, research, campus management, and social outreach. HEIs are considered a platform through which to integrate knowledge from diverse disciplines rather than one perspective to foster human resources with cross-cutting skills and knowledge on building a sustainable world (SDSN, 2020). HEIs also provide multiple solutions to deal with interconnected problems in building global sustainability (SDSN, 2020).

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Education for sustainable development (ESD) in higher education has become one of the most important roles of HEIs in achieving the SDGs. For instance, sustainability education should enhance learners' skills and knowledge of sustainability issues.¹ However, rather than simply reflecting the current challenges from social, economic, and environmental perspectives, sustainability education must enable students and professionals to transform society for the better. (Dale & Newman, 2005). The objectives of ESD are to cultivate sustainability literacy and competencies (e.g., communication skills, leadership, and management capacities) and the ability to understand the core principles of sustainability issues, including holistic thinking, transdisciplinarity, and diversity (Kishita et al., 2018). Universities are expected to enable students to be equipped with cross-cutting skills and 'key competencies' related to the SDGs. These key competencies include systems thinking, critical thinking, self-awareness, integrated problem-solving, and anticipatory, normative, strategic, and collaborative competencies; creativity, entrepreneurship, curiosity and learning skills, design thinking, social responsibility, partnership competencies, and being comfortable in interdisciplinary settings (Australia/Pacific, 2017, p. 12). In order to achieve these objectives, HEIs have been using ESD elements as catalysts for innovation in education. Regarding curriculum, approaches include adding new courses and modules with ESD elements and integrating sustainability in current study and research programs. Many new forms of learning, such as interdisciplinary learning, project-based learning, and case studies have been emerging (Wals, 2012).

Interdisciplinary teaching and learning has been widely considered as an approach for ESD. Interdisciplinarity is defined as "a means of solving problems and answering questions that cannot be satisfactorily addressed using single methods or approaches" (Klein, 1990, p. 196). It also refers to the process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession (Klein & Newell, 1998, p. 3). Klein (2006, p.16) further addresses that interdisciplinarity is a key to universities rethinking their purposes and practices at a fundamental level, suggesting

that, "the ultimate goal is to reconstruct what is taught and how it is taught."

Interdisciplinary education and ESD provide a complementary approach to enhancing learners' interdisciplinary competences and sustainability competencies (Blake et al., 2013; Grierson & Munro, 2018). An interdisciplinary approach is considered a crucial method for teaching sustainability issues relevant to engineering, architecture, science, environment, and business in universities (Annan-Diab & Molinari, 2017; Grierson & Munro, 2018; Holgaard et al., 2016). Moreover, in recent years, there have been emerging initiatives in integrating sustainability issues for enhancing interdisciplinary teaching and learning in universities. And there are diffusion and infusion modes of the integration process. The former refers to the new programs and courses on environmental studies and sustainability studies. The latter integrates environmental contents into existing courses as one of the topics that comprise the course (Michel, 2020). However, there are more research on the diffusion mode in contrast to the infusion mode. Reid and Petocz (2006) argue that education materials/resources on sustainable development should be spanned to a whole range of subjects and curriculum rather than limiting the focus on environmentally focused disciplines. Without focusing on programs/courses of environmentally related studies, this study explores how ESD could enhance interdisciplinarity in teaching and learning in courses whose objective is not to teach sustainability per se, but to use sustainability as topics to nurture competencies necessary to create a sustainable society. The present paper describes a study of two cases at a comprehensive research university in Japan, including an undergraduate general education course of a global leadership program and an interdisciplinary postgraduate course titled "Edu-Fair/Fare Mind". The rest of the paper is organized as follows. First, it reviews the discussion on the relationship between sustainability and interdisciplinarity in higher education and introduces a framework of interactive teaching and learning. Then, it introduces the research methods, the background of the study, and data collection procedures. Next, the findings from two case are presented. Finally, it discusses achievements of and barriers to integrating sustainability themes into interdisciplinary teaching and learning in university education. Moreover, it provides implications of a complementary relationship between sustainability and interdisciplinarity for innovating and rethinking teaching and learning in higher education. It concludes by indicating the limitation of the study as well as the possibility of future study.

¹ According to UNESCO (n.d.), sustainability is defined as a paradigm for thinking about the future in which environmental, societal, and economic considerations are balanced in the pursuit of an improved quality of life. In this study, we define sustainability issues as broader themes specified by complex issues in terms of social, economic, environmental, and cultural development in the global context. The United Nations describes global issues were issues that transcend national boundaries and cannot be resolved by any one country acting alone (United Nations, n.d.). Global issues present details of challenges of human beings and the planet formulated by social, economic, environmental, and cultural development.

Literature review

Sustainability education in higher education

HEIs have contributed to sustainable development (Lozano et al., 2015; Nhamo & Mjimba, 2020; Owens, 2017). A worldwide survey indicates that there has been substantial progress in terms of initiatives for the institutional integration of sustainable development into curriculum and courses in higher education (Leal Filho et al., 2019). There are two main approaches by which sustainable development may be integrated into higher education. One is to incorporate it into all programs at a university. The other is to foster sustainable development specialists by establishing sustainable development programs (Sherren, 2006).

There has been an evolution in higher education for sustainable development. According to Wu and Shen (2016), between 2005 and 2009, higher education for sustainable development was environmentally focused; and between 2010 and 2014, the focus shifted toward promoting the concepts of interdisciplinary integration and business education for sustainable development. There is currently a growing interest in fostering students' competencies of sustainability issues. Research shows there are five key competencies in sustainability: systems thinking competence, anticipatory competence, normative competence, strategic competence, and interpersonal competence (Cebrián & Junyent, 2015; Cebrián et al., 2020; Dale & Newman, 2005). Other scholars defined sustainable development competencies as types of knowledge, skills, and attitudes that enable successful task performance and problem-solving with respect to real-world sustainability problems, challenges, and opportunities (Dale & Newman, 2005; Vermeulen et al., 2014). Moreover, a worldwide comprehensive review of competencies for students who major in sustainable development indicates that 11 unique competencies can be grouped into three categories: (1) competencies of intellectual abilities, (2) competencies of interacting, and (3) competencies of self-development. Intellectual abilities includes systems thinking and analytical/integrative capacity, professional and holistic knowledge, research and ICT skills, and the ability to think and work on future scenarios; interacting abilities refer to leadership, social skills, management skills, and communication skills; and self-development competencies consists of acting as a change agent for sustainability, personal value development, understanding ethics and social systems, self-discipline, and a sense of responsibility (Vermeulen et al., 2014).

Although most HEIs have a high level of recognition of the importance of integrating the SDGs into teaching and learning, research shows much lower levels of application

in practice. Furthermore, these applications are compartmentalized and not holistically integrated (Leal Filho et al., 2019; Lozano et al., 2015). Common barriers to implementing ESD at universities, include lack of training, the difficulty of incorporating the SDGs into courses, and lack of support from top management (Lazzarini et al., 2018; Leal Filho et al., 2019). Curriculum change for sustainable development is, thus, one of the most challenging obstacles higher education faces when responding to the sustainability agenda. Research shows obstacles include the wall between natural sciences and social sciences, institutional governance, structures, financial resources and culture clashes between disciplinary fields (Blake et al., 2013).

Interdisciplinary education

Interdisciplinary education refers to the integration of knowledge from diverse disciplines to address problems that cannot be solved by a single disciplinary perspective (Ashby & Exter, 2019; Holley, 2017). Interdisciplinary higher education emphasizes boundary-crossing skills, which refer to the ability to change perspectives, synthesize knowledge of different disciplines, and deal with complexity (Klein, 2006; Spelt et al., 2009). Since the 1970s, the role of interdisciplinarity has been the focus of attention in teaching and research at universities. The term interdisciplinarity has been defined as,

an adjective describing the interaction among two or more different disciplines. This interaction may range from simple communication of ideas to the mutual integration of organizing concepts, methodology, procedures, epistemology, terminology, data, and organization of research education in a fairly large field. An interdisciplinary group consists of persons trained in different fields of knowledge (disciplines) with different concepts, methods, and data and terms organized into a common effort on a common problem with continuous intercommunication among the participants from the different disciplines. (OECD, 1972, p. 25).

In 2008, the G8 University Summit emphasized the role of universities to educate young generations, disseminate knowledge, and teach the skills needed to tackle regional and local issues through an interdisciplinary approach (Hokkaido University, 2017).

Interdisciplinarity enhances the ability to understand complex challenges and encourage sustainable development (Annan-Diab & Molinari, 2017). An interdisciplinary approach is crucial for teaching SDGs in universities and could provide a basic overview of a wide range of topics with expertise from various disciplines. It could also enhance understanding of the interconnective relationships

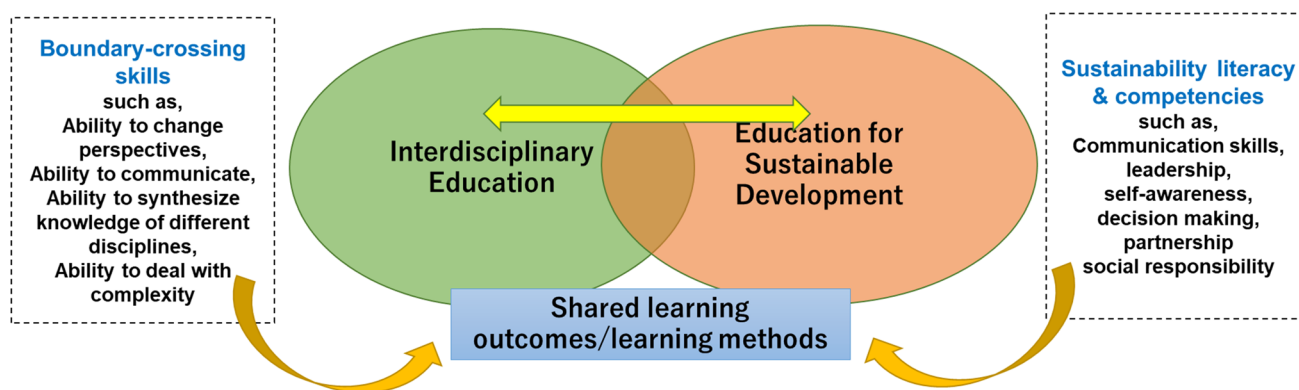


Fig. 1 Complementary relation between interdisciplinary education and education for sustainable development. *Source* Authors

among the 17 goals of sustainable development. Furthermore, it could better promote collaboration between different departments and schools (SDSN, 2020). At the same time, the ESD could enhance liberal education, interdisciplinarity, cosmopolitanism, and civics studies (Wu & Shen, 2016). The sustainability agenda is considered a major force for a more interdisciplinary approach to teaching and learning in education (Blake et al., 2013). Implementing ESD can enhance interdisciplinary skills relevant to all learners' general education (Kishita et al., 2018; SDSN, 2020; Yarime et al., 2012).

There are different motivations for engaging with interdisciplinarity. For students, motivations include improving their ability to: adjust to shifting job markets, develop new career paths, sense the relevance of their subjects, and develop more flexible skills. For teachers, motives for engagement include: finding solutions to problems of growing specialization, working toward common goals, opening up new fields of knowledge, and breaking down divisions between universities and society (Lyall et al., 2015). The demand for interdisciplinary competencies also comes from businesses, who wish to hire graduates equipped with the ability to adapt to rapid change and solve problems in complex situations (Jacob, 2015; Power & Handley, 2019).

ESD and interdisciplinary education share similar learning outcomes, such as the ability to integrate or synthesize knowledge from different disciplines. These learning outcomes are common for most education courses and programs in HEIs. Therefore, HEIs could potentially integrate both ESD and interdisciplinary education at a broader scale in order to foster knowledge of sustainable development and interdisciplinary competencies of learners.

Linking interdisciplinarity with sustainability in education

There are at least two ways to understand the relationship between interdisciplinarity and sustainability in education.

On the one hand, interdisciplinarity is a means for understanding sustainable development, since sustainable development presents an overarching and complex socio-economic-ecological context wherein interdisciplinarity is a putative holistic mode of understanding, an organization of knowledge, and a method of inquiry (Blake et al., 2013; Jones et al., 2010). On the other hand, as Fig. 1 indicates, interdisciplinary education and ESD provide a complementary approach of enhancing learner's interdisciplinary competencies (boundary-crossing skills) and sustainable development competencies (sustainability literacy and competencies). The approaches identified to advance interdisciplinarity in HEIs share many characteristics with learning methods deemed conducive to ESD (Grierson & Munro, 2018). For example, ESD emphasizes learning methods such as disciplinary learning, discovery learning, and participatory learning. Moreover, interdisciplinary education uses group discussions as a crucial teaching method. Thus, HEIs should adopt shared learning methods and teaching activities for ESD to develop more comprehensive learning and interdisciplinary education.

The complementary relationship between interdisciplinarity and sustainability in education provides integrated learning outcomes and learning methods for universities to reconsider teaching and learning activities, which can better prepare students to build a sustainable future. Moreover, besides cognitive development of learners, this complementary relationship has the potential to enhance non-cognitive development of learners, including personal value development, understanding ethics and social systems, self-discipline, awareness/sense of social and moral responsibility, and the ability to act as a change agent for sustainable development (Vermeulen et al., 2014). In contrast to educational programs for sustainability studies that aim to foster learners' intellectual and interactive skills, this complementary relationship has the potential to enhance teaching and learning in a broader range of courses, including general education and other non-environmentally related courses, which

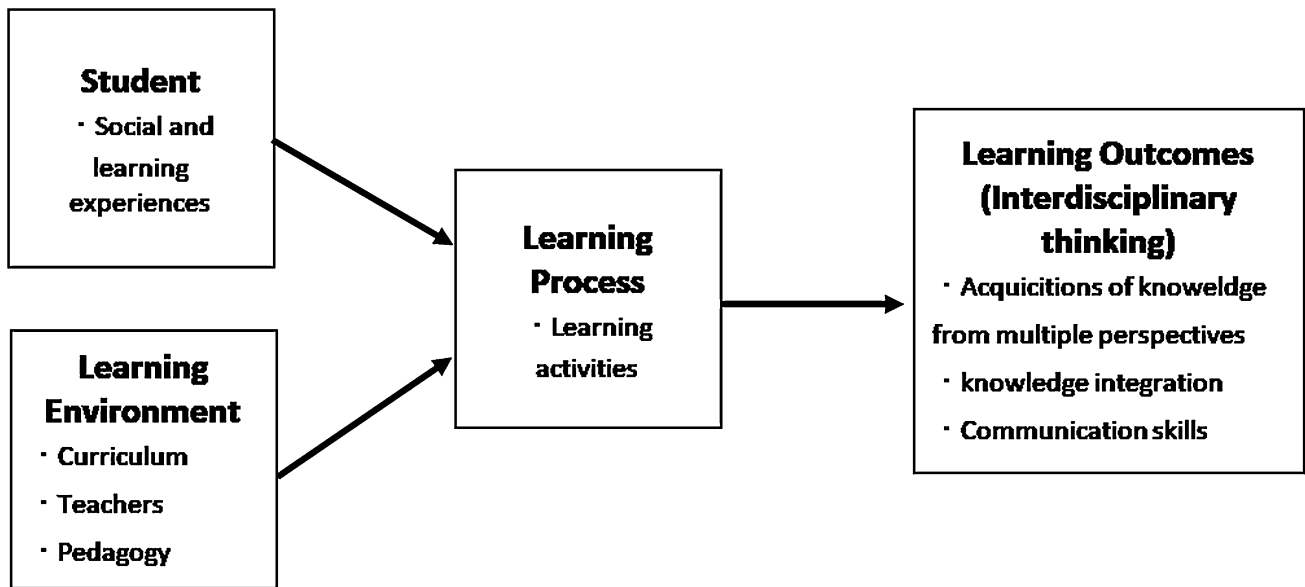


Fig. 2 Comprehensive model of teaching and learning in enhancing interdisciplinarity. *Source* Adapted from Biggs's model (1993, p.75), authors made

will strengthen the non-cognitive perspectives of sustainability competencies of learners.

Research framework

A comprehensive model of teaching and learning in higher education provides us a framework to explore the processes and outcomes of integrating sustainable development themes into interdisciplinary teaching and learning. According to Biggs (1993), an interactive ecosystem of teaching and learning consists of four components, including students, learning environment, learning process, and learning outcomes. In interdisciplinary higher education, students and the learning environment are pre-conditions to the learning process. Moreover, they jointly promote learning activities in the learning process. Consequently, the learning process generates learning outcomes of interdisciplinary thinking (see Fig. 2).

Students are key players in teaching and learning. Their curiosity, respect, openness, patience, diligence, self-regulation, and social and learning experiences can facilitate teaching and learning processes. Learning environments consist of a curriculum, teachers, pedagogy, and assessments. Curriculum refers to a balance between disciplinary studies and interdisciplinary studies. Teacher components include the intellectual community focused on interdisciplinarity, expertise of teachers on interdisciplinarity, consensus on interdisciplinarity, team development, and team-teaching. Pedagogy includes training aimed at achieving interdisciplinarity, active learning, and

collaboration. Moreover, assessments includes the assessment of students' intellectual maturation and interdisciplinarity abilities (Biggs, 1993, 2003; Spelt et al., 2009).

The learning process refers to learning progress, learning activities for achieving interdisciplinarity, and reflection. Learning outcomes, in this case interdisciplinary thinking, reflect knowledge from across disciplines and interdisciplinary paradigms. It also consists of higher-order skills and communication skills (Biggs, 1993, 2003; Spelt et al., 2009). The former implies the ability to search, understand, connect, and integrate knowledge from different disciplines and apply advanced cognition to the next learning procedure (Ivanitskaya et al., 2002; Spelt et al., 2009). The latter suggests to the necessary language capacity to understand discourses from different disciplines to further negotiate, develop common understanding, and communicate to a broad and diverse audience (Spelt et al., 2009; Woods, 2007).

By adopting this framework, this study analyzes how the integration of sustainability issues into non-environmentally related courses at undergraduate level and post-graduate level at Tohoku University, a comprehensive research university in Japan, enhances interdisciplinary teaching and learning. Figure 2 shows that in this study student component focuses on students' social and learning experiences. Learning environment includes perspectives of curriculum, teachers, and pedagogy. In learning process, details of learning activities will be analysis focus. And the analysis of learning outcomes includes perspectives of knowledge acquisitions, knowledge integration, and improvement of communication skills.

Research methods

This research adopted a case study method. This method provides an in-depth examination of a single instance of some social phenomenon (Babbie, 2020, p. 305). To better understand the integration of sustainability themes into interdisciplinary teaching and learning in courses that are not environmentally related, the authors selected two cases: (1) an undergraduate general education course, “Global Seminar” (GS), which is a required course for the Tohoku University Global Leader (TGL) Program (Case I) and (2) a postgraduate course, “Edu-Fair/Fare Mind”, which is a required course for master’s students at the Graduate School of Education (Case II). Moreover, besides developing learners’ cognitive abilities, both courses have learning objectives of enhancing the non-cognitive development of learners, including the ability to act as a change agent for sustainable development and a sense of social and moral responsibility. The two cases have potential to present both cognitive and non-cognitive learning outcomes achieved through integration of sustainability themes into interdisciplinary teaching and learning in courses. Moreover, both cases have the potential to show the reference of enhancing interdisciplinarity of learners in the stage of educational transition from secondary education to tertiary education in Case I and from undergraduate to postgraduate education in Case II.

In Case I, we unveiled the process and outcomes of integrating sustainability themes into teaching and learning of GS. Tohoku University was selected as one of 42 universities for MEXT’s Project for Promotion of Global Human Resource Development, which aimed to help Japan’s younger generation overcome their “inward tendency” and foster human resources with the goal of improving Japan’s global competitiveness. The University developed the TGL program, aiming to nurture global leaders defined as individuals “who will be able to steer our unpredictable global society and create new values of various areas in industrial-academic-government cooperation” (Tohoku University, n.d.). Six key global competencies are outlined: (1) professional expertise in a specialized area, (2) the ability to examine an issue from broad perspectives, (3) problem-solving skills, (4) international and intercultural understanding, (5) communication skills, and (6) leadership skills. To cultivate the key competencies, around 250 TGL classes are categorized into four sub-curricular groups: foreign languages and communication, international liberal arts, power of action learning, and overseas study and training. To examine possibilities for and barriers to enhancing interdisciplinarity in teaching and learning by integrating sustainability themes as learning catalysts, we surveyed four of five GS instructors in

Table 1 Characteristics of the Surveyed Instructors

Instructor	Expertise	Affiliated unit
A	Gender studies	Global learning center
B	International education	Global learning center
C	International education	Global learning center
D	English language education	Global learning center

Japanese in December 2020, regarding interdisciplinary learning for general education. The instructor, who didn’t participate in the survey was one of the authors. Table 1 shows the characteristics of the instructors. They have different expertise in gender studies, international education, or English language education while all of them belong to the Global Learning Center, which promotes the internationalization of education at Tohoku University.

We distributed online questionnaires to the instructors who designed and implemented GS. The questionnaire includes all open-ended questions on curriculum design, pedagogy, learning activities, learning outcomes, and challenges for further improvement, related to interdisciplinary learning.

In Case II, we analyzed the integration of sustainability themes into teaching and learning of a postgraduate course titled “Edu-Fair/Fare Mind,” a compulsory course for first-year master’s students and an elective course for first-year doctoral students at the Graduate School of Education. The course was first offered in 2018, when the Graduate School of Education was reorganized as a multidisciplinary institution consisting of six research departments: Sciences of Lifelong Education, Education Policy and Social Analysis, Global Education, Educational Informatics and Innovative Assessment, Educational Psychology, and Clinical Psychology. The term “Edu-fair/are” is a neologism created by combining the phrases “education for fairness” and “education for welfare.” This course was developed based on the concept of Edu-fair/fare mind, which stresses the value of developing a society in which people—including those with various difficulties—are treated fairly and can realize happiness (welfare). In order to foster this mind, the course adopts an interdisciplinary approach that includes graduate students and instructors from diverse research fields discussing fairness and issues of inclusion in society. Sustainable development themes relevant to these issues, such as quality education, good health and well-being, and inequality, are used in this course.

To explore how the integration of sustainability issues into teaching and learning could enhance interdisciplinary teaching and learning, we conducted semi-structured interviews between December 16 and 25, 2020, with eight students who participated in the course. The questionnaires mainly include questions, such as “What impressed you

Table 2 The characteristics of student interviewees

Student	Grade	Gender	Nationality	Employed	Overall evaluation of the course
A	M1	Male	Foreign	No	Relatively low
B	M1	Female	Foreign	No	High
C	M1	Male	Japanese	Yes	High
D	M1	Female	Japanese	Yes	High
E	M1	Male	Foreign	No	Relatively low
F	M1	Male	Japanese	No	Relatively low
G	D1	Female	Foreign	Yes	High
H	D1	Male	Japanese	No	Moderate

Table 3 The characteristics of instructors

Instructor	Expertise	Affiliated unit
U	Cultural anthropology	Graduate school of education
X	Developmental disabilities	Graduate school of education

in this class compared to the undergraduate and graduate classes you have taken so far?” “Do you think the discussion-style lessons helped shape the Edu-fair/fare Mind?” “Is there anything you feel you have learned through discussions with students from other research fields/areas?”. Two of the eight students were interviewed in-person, and six were interviewed online. In order to include diverse opinions on this course, we selected the eight students based on their overall evaluation of this course. Table 2 indicates the characteristics of the interviewees. With consent from the interviewees, all interviews were recorded. We also conducted semi-structured interviews with two instructors (Instructor U and X) who were involved in this course in 2020. The questionnaires mainly include “Do you think the Edu-fair/fare Mind courses play a role in the development of interdisciplinary education at this graduate school?” “What did you consider when choosing a theme for developing Edu-fair/fare mind?”. Table 3 shows the characteristics of the instructors. The reason for selecting Instructor U is that the instructor’s lecture content was one of the most mentioned by the student interviewees. The reason for selecting Instructor X is because the instructor has been involved in this course since 2018. Interviews with instructors were conducted online on January 19 and 21, 2021.

Transcriptions of the interview data were created and then coded using MAXQDA Plus 2020. Codes were then organized into categories in line with the questionnaire items. Within each category, subcategories were created based on similarity between codes. By borrowing Biggs’ comprehensive model of teaching and learning in higher education, the following section analyzes the two cases from

four perspectives: students’ features, learning environment, learning process, and learning outcomes.

Case 1: an undergraduate general education course, Global Seminar

The reason for including this case was to investigate whether integrating sustainability issues as learning topics can enhance interdisciplinary teaching and learning in an undergraduate general education course. Global Seminar (GS), the introductory course required for the Tohoku University Global Leader (TGL) Program, is discussed. In GS, sustainability themes are introduced to students from different academic fields. These themes are used as learning catalysts to assist students in discussions regarding issues in a globalizing and diversifying society and the necessary competency to contribute to the creation of a future society as a global citizen. For this case, first, information on students’ backgrounds is provided. Then, GS curriculum design and the findings of GS instructors’ perspectives on interdisciplinary learning are presented. Finally, in the discussion, challenges for enhancing interdisciplinarity in teaching and learning for an undergraduate general education course are explored and reflected.

Students

Students from all ten faculties have registered for GS. The ratio of male to female students in GSs is roughly 1:1, although the number of male students is slightly higher. Considering the gender ratio of male to female undergraduates at Tohoku University is 3:1, GSs have a high proportion of female students. Before entering the university, about 60% of students have international experience, such as an overseas trip, studying abroad, and living abroad due to parents’ work assignments. Tohoku University offers five classes in the spring semester and two classes in the fall semester. The quota for each class is 24 students, and the students are selected to enroll in the course. These students tend to be inquisitive and highly motivated.

Learning environment

Teachers

Five instructors, including one of the authors of this paper, teach GS. All instructors belong to the Global Learning Center, which plays a pivotal role in the establishment and execution of Tohoku University’s education internationalization strategy and in the promotion of international exchange activities. Three of them have similar academic backgrounds related to international education, one has expertise in

English language education, and one has expertise in gender studies.

All four instructors who responded to our survey regarded interdisciplinary learning as essential for general education. Specifically, they recognized that interdisciplinary learning has a positive effect on developing general skills. Two primary skills identified were *the ability to regard an issue from multiple perspectives* and *the ability to integrate knowledge*.

All four instructors identified the importance of acquiring multiple perspectives. This was described as “a broader perspective” (Instructor B), “multifaced thinking” (Instructor C), and “the habit of looking at things from multiple perspectives” (Instructor D). Instructor A noted the importance of multiple perspectives to solve contemporary problems of Japanese society:

Our familiar social issues are now related to global issues. Under the circumstance, in terms of specialized education (research) as well as general education, interdisciplinary, integrated learning is effective since it allows students to tackle the issues in a complex, real human society, not only from [the perspectives of] multiple disciplines instead of only one discipline [perspective] but also from a global viewpoint.

Three instructors identified the ability to integrate knowledge. Instructor C noted “abilities such as advanced comprehension and integration of diverse knowledge,” while Instructor D stated “the ability to integrate diverse knowledge across disciplines.” Instructor B explained that students would practice such skills through interdisciplinary learning and noted, “To nurture a broader perspective, students from different academic disciplines must engage in dialogues from a cross-disciplinary perspective and enhance the integrated comprehension related to the real world.”

Curriculum

Five faculty members, including one of the authors of this paper, instruct GS, and seven classes are offered per year. Each class takes 20–24 students, so about 160 students take the course per year. GS was first offered in 2016, and students were required to take it within their first three semesters. The majority of students take GS during their freshman year, and roughly 6–7% of first-year students take the course.

The goal of GS is to prepare students to be independent learners during their university lives and take a leading role as global citizens in the twenty-first century. The course aims to develop essential general skills to achieve this goal, and the following three learning objectives are set:

- (1) Students can expand their capacity for dialogue by developing active listening and expressiveness through

experiential learning, including discussion and presentation.

- (2) Students can acquire knowledge from various angles to understand phenomena and issues in the actual world and develop their own ideas.
- (3) Students can develop planning, self-management, and action-taking skills through a deep consideration for leadership in a globalized society.

All GS instructors share the same goal and learning objectives. To achieve the three learning objectives, two learning themes are selected: essential social issues in a globalizing and culturally diversifying society and key competencies for living in a society under the ongoing process of globalization and diversification.

Pedagogy and learning process

Typical learning activities in GS are a problem-based group project for the first topic and an individual presentation and essay for the second topic. Details of the learning activities differ among instructors. The following is a description of the learning activities provided by the GS instructor who is also an author of this paper.

Two main learning activities:

- (1) Group Project: facilitate an 80-min session, consisting of a presentation, group and class discussions, and conclusion, on the issue that each group identified most important to discuss in class in order to live in the society under the ongoing process of globalization and diversification
- (2) Individual Poster Presentation and Essay: present and communicate students’ own vision, objectives, and plan to live in society under the ongoing process of globalization and diversification

Instructors also co-facilitate three classes to enhance these learning activities an SDGs workshop and two guest lectures on career development and global competencies. The SDGs workshop and two guest lectures are designed to be learning catalysts to help students engage in the activities mentioned above. More specifically, students will:

- Examine the world where they will live and discuss how they have been impacting global problems and how they could/would contribute to solving them,
- Expand the scope of group projects and narrow their themes,
- Consider what competencies (i.e., knowledge, skills, attitudes, and behaviors) they need to create a sustainable society and live as an international/global citizen of the twenty-first century,

- Think about their future vision, objectives, and plan as an international/global citizen of the twenty-first century.

Learning outcomes

Three primary learning outcomes emerged from the four GS instructors' survey data. Two learning outcomes were *acquiring multiple perspectives* and *developing the ability to integrate knowledge*. The instructors expected that interdisciplinary learning could have an impact on these learning outcomes. *The improvement of communication skills* was recognized as the third learning outcome.

First, *the acquisition of multiple perspectives* was observed by all four instructors. They noted, "broadened their perspectives" (Instructors A and B), "developed the ability to think from multiple perspectives" (Instructor D), and "had opportunities to begin to think how to design career paths [by participating in guest lectures]" (Instructor C). Three instructors mentioned that using a problem-based group project as a learning activity resulted in developing this competency, while two instructors identified guest lectures. Instructor B regarded both learning activities as effective:

Although I did not properly [methodologically] verify its effect, recalling student comments, I often read the comments saying they broadened their perspectives through discussions among students from different disciplines and listening to the different alumni's lectures. Students broadened their perspectives by being matched with students from different disciplines for small group discussions and group work and listening to students' presentations with different disciplines and guest speakers.

Second, *the ability to integrate knowledge* was observed by two instructors. These instructors said group work and group discussions were key learning activities to develop this competency. Instructors A stated, "I observed, through the group work, including discussions with students from different academic disciplines and fields, students developed...the ability to produce a more valid idea, integrating different perspectives," while Instructor D explained, "In discussions, students were required to develop a logical argument and assume dissenting opinions. As a result, they nurtured the ability to think from multiple perspectives."

Finally, the development of *communication skills* was identified by three instructors. Precisely, "presentation skills," "the ability to convey ideas to others," and "listening skills" were noted. Instructor C noted, in GS, students have at least two opportunities to make a presentation; therefore, they have a chance to reflect on the first presentation and improve their second presentation with their target audience in mind. Meanwhile, Instructors A and D stated "the ability

to convey ideas to others," which was improved through group work and discussions. Instructor D described how students developed this ability throughout the semester:

In the learning activity to propose a group project topic, students were expected to summarize ideas and opinions among group members of different disciplines and share the result in class. At the beginning of the semester, by and large, I observed that students could not summarize and convey ideas to others sufficiently. However, they improved those abilities with each class.

Instructor D also listed "listening skills" by quoting student comments: "I learned a lot about how I should listen to other people's opinions," and "I developed the ability to listen to group members' opinions first without denying them."

Challenges and reflection

Three different challenges to enhancing interdisciplinary learning emerged. Those challenges are the limitation of fixed learning groups, the instructor's subject matter capacity, and balancing the learning workload.

The first challenge was noted by Instructors A and D. Both instructors promoted interdisciplinary learning through activities related to a problem-based group project. To complete a group project, students worked with the same members throughout the semester. Although a group consisted of students from different academic disciplines, they interacted with a limited number of students in the class. Instructor A noted additional learning activities for interdisciplinary learning, while Instructor D mentioned promoting interactions among groups as a remedial measure.

The second challenge, the instructor's subject matter capacity, was identified by Instructor B. The instructor implied the limitation of one instructor's subject matter capacity to promote interdisciplinary learning:

Considering the definition of interdisciplinary learning, I can promote interactions among students from different academic disciplines. Meanwhile, my challenge is how I, as an instructor, could acquire a wide range of interdisciplinary knowledge and teach [students from diverse academic disciplines].

In general, faculty members belong to an academic discipline and have their own academic expertise. When global issues referring to SDGs are widely employed as a learning theme, most instructors must feel that they are challenged to acquire broad knowledge beyond their expertise. Although GS's objective is not to help students gain specialized knowledge on global issues but to help them develop general skills, instructors need to have some capacity to guide students to conduct a selected problem-based group project.

The instructors need time to update their knowledge on the topics students selected as their group projects.

The last challenge, balancing learning workload, was identified by Instructor C. This instructor noted, “Determining learning workload students can handle (To what extent I ask students to deepen their learning will depend on how much time they can allocate to study for a course).” A problem-based project with a group of students from different academic disciplines could be quite time-consuming. Thus, providing clear guidelines for a group project and observing its progress are essential. This case depicted an interdisciplinary model of general education, in which this model adopted a skill-oriented approach to teaching, and the content or knowledge component (or subject matter) is a learning catalyst with which the selected generic skills are nurtured. The selected subject matter is global issues referring to SDGs. These goals and their key related concepts (such as globalization, sustainable development, global human resource, and global citizenships) fit well to two concept selection criteria for teaching in interdisciplinary course, which are “salient in understanding the problem” and “of interest more than one discipline” (Hursh et al., 1983, p. 51). Furthermore, students select a critical global issue for the assigned group project, in which they need to identify key concepts related to the issue, discussed with interdisciplinary group members, and integrate different ideas to present to the class. The course instructors identified three generic skills, such as multiple perspectives, the ability to integrate knowledge, and communication skills, as the outcomes of interdisciplinary learning in the Global Seminar. Students nurtured those skills mainly by tackling a problem-based project with interdisciplinary group members, which provides four out of five key learning elements of a successful interdisciplinary general education curriculum identified by Carmichael et al. (2017). Four elements are a student-centered learning environment, active learning projects, primary research, and informed discussion of challenging texts, while an interdisciplinary faculty team-teaching is missing.

Case II: a postgraduate education course, “Edu-Fair/Fare Mind”

This case examined how integrating sustainability issues into teaching and learning could enhance interdisciplinary teaching and learning in a postgraduate education course titled “Edu-Fair/Fare Mind”. The “Edu-Fair/Fare Mind” course adopted sustainable development themes, such as inequality, fairness, inclusion, and diversity, as learning catalysts to assist students from different fields in understanding and discussing a society in which people should be treated fairly to realize happiness (welfare). In this case, first, information on students’ backgrounds is provided. Then, the learning

environment, including information of instructors and details of the curriculum, are introduced. In the following sections, the learning process and learning outcomes of this course are presented. Finally, challenges for enhancing interdisciplinarity in teaching and learning for a postgraduate education course are discussed and reflected.

Students

In 2020, there were 44 first-year master students and seven first-year doctoral students (Among them, there were 16 international students) in this course. For group discussion, they were divided into eleven groups, including a diversity of students in the research field, grade (master or doctoral), and their cultural background (domestic or foreign). Furthermore, some students who are working adults were purposefully distributed into different groups since their experience could be learning supplements for other students.

Learning environment

Teachers

Seven faculty members (one facilitator and six instructors) worked as an interdisciplinary team for teaching this course in 2020. The Graduate School of Education consists of six research departments. Each department annually selects at least one instructor for this course. This interdisciplinary team includes instructors in anthropology, educational assessment, international development, sociology, educational psychology, and clinical psychology.

The main objective for developing this course was to provide a platform to deepen understanding of fairness and inclusion; however, Instructor U recognized that this course could enhance students’ interdisciplinarity in research and better understand diversity. As Instructor U elaborated,

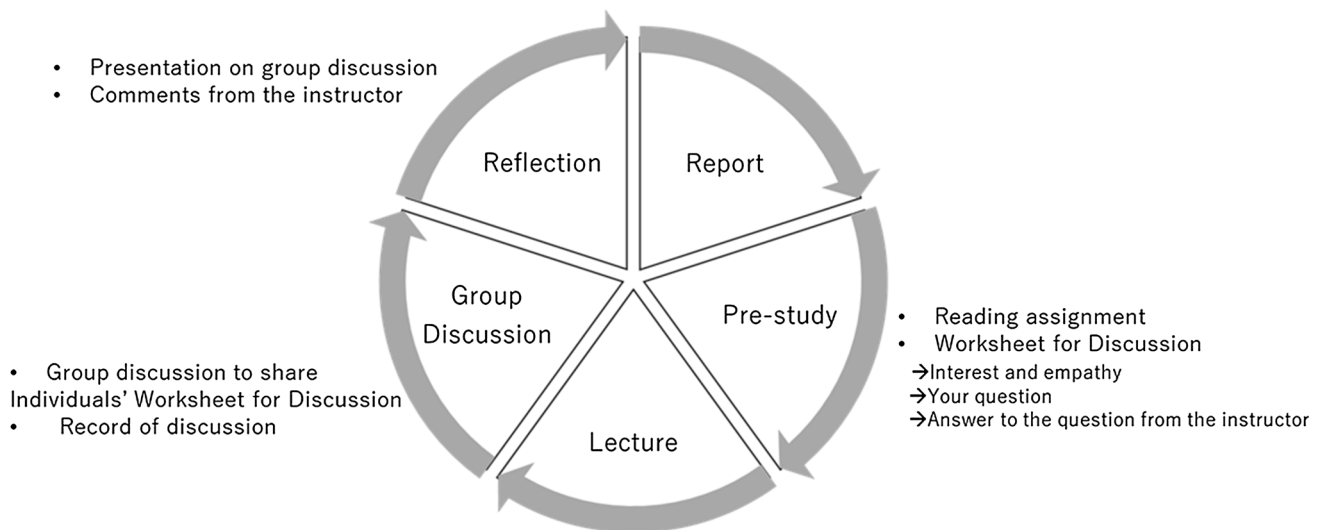
What attracted me to this class in the first place may have been the theme itself, but I also thought that we could directly discuss and communicate the attitude of a researcher. In the end, I think that the attitude of researchers is to understand various things correctly, which will ultimately lead to inclusion, acceptance of various things, flexibility, and so on. I have to force myself to make this connection.

Curriculum

“Edu-fair/fare Mind” is the first-quarter course, consisting of eight lessons (one credit). It is a required course for the two-year Master’s Program (First Term Program) and an elective course for the three-year Doctoral Program (Second Term Program). There are eight sessions, including two

Table 4 Session themes

Instructors	Themes
U	Research conduct and researchers
V	What is fair and equitable education in the age of the Act on the Promotion of Computerization of School Education?
W	Inclusive, equitable and quality education provision for children with foreign connections
X	(1) International classification of functioning, disability, and health (2) Survey results of students who need special educational support with potential developmental disabilities, who are enrolled in regular classes
Y	What do you think of the scholarship system?
Z	In cases of <i>hikikomori</i> , the psychosocial process from the stage of initial recontact with society to the decision to find a job

**Fig. 3** Learning process of Edu-fair/fare Mind course

sessions on research ethics and six workshop-style sessions on topics related to “Edu-fair/fare Mind.” These topics are closely related to the SDGs, such as equity, quality education, inclusiveness, innovation, and health and well-being (see Table 4). Interviews with instructors showed their intentions to connect the theme to the need for fostering students’ interdisciplinary skills. Instructor X chose themes that enabled students from different fields to express their opinions easily. And Instructor U selected themes which could foster students to become future researchers for diversity.

Pedagogy and learning process

There are five steps during each session in this course. As Fig. 3 indicates, these steps are pre-study, lecture, group discussion, reflection, and report writing. In pre-study, students are required to read the articles selected by the instructor and fill in the “Worksheet for Discussion,” including three items titled “Interest and empathy,”

“Your question,” and “The Question from the teacher.” The instructor gives a 30-min lecture regarding the article and materials shared with students in advance. After the lecture, students are required to have a group discussion to share their answers in the “Worksheet for Discussion”. They also discuss the themes of the session. Groups are assigned to diverse groups in terms of research field, year of study, nationality, and occupation. The group also elects a secretary who keeps a “Record of Discussion”. In the reflection, each group representative shares the group discussion results, and all students can make comments. Moreover, the instructor also makes comments on the discussion and answers questions raised by the students. After the session, students write the report within two weeks to reflect on what they learned and submit it via Google Classroom. In 2020, due to the COVID-19, this course was transferred from in-person teaching to synchronous online teaching through Google Meet.

Group discussion

Interviews with students showed group-based discussions on Edu-fair/fareness issues played a positive role in enhancing students' interdisciplinary skills. The group discussion allowed students to listen to others' opinions about diversity, which helped them form their own Edu-fair/fareness minds. Through discussions, students learned that they need to be receptive to different opinions. They understood this by connecting it to the philosophy of fairness and inclusion of the Edu-fair/fare Mind. The interview with Student D indicated that group discussions were helpful in allowing students to listen to others' opinions:

The students from other courses had different points of view, and I thought, "Oh, there is such a perspective. The psychology students were thinking from a psychological point of view, the public administration students were thinking from an administrative point of view, and the international students had a different point of view. It was very helpful to hear about these various perspectives.

Moreover, interviews indicated a positive role that international students play in enhancing Japanese students' understanding of fairness in education. Japanese students' discussions with international students enabled them to deepen their understanding of the Edu-fair/fare mind. Instructor X also affirmed the participation of international students provided diverse opinions to the discussion and provided multicultural experiences to all participants.

At the same time, interviews with international students showed that it is necessary to pay attention to language proficiency and communication skill among both Japanese and international students to enhance mutual understanding in the discussion. As Student A specified,

When we submit our ideas about China, the Japanese students are often interested and ask questions about it. However, it is a little difficult to ask questions because sometimes the topics that Japanese students discuss are spoken so fast that we could not understand them well.

Learning outcomes

Research findings showed that both students and instructors benefited from this course. First, this course enhanced students' understanding of the importance of interdisciplinarity and diversity in their learning process. Interviews with students indicated that the course provides a variety of topics by instructors from various fields, which broadens students' visions and enables them to speak with many students in different disciplines. Student D pointed out that this class

provided a new experience to learn from instructors in various fields, and student B emphasized,

I really appreciated the fact that the class covered a variety of fields. I hadn't really considered topics such as educational administration or psychology before the class, but I think I was able to broaden my horizons by learning about so many different fields.

Student G declared this course enabled her to develop an active attitude towards a fair and inclusive society. She stressed,

I think it is necessary. I have an impression of a fair and inclusive society in this class. I discussed it in a group with students from other courses. I still remember it. I still have an impression of it. I've never heard of fairness and inclusion before this. It was very interesting.

Moreover, the session on research ethics was one of the most memorable for students involved in the interviews. This lecture emphasized the understanding of diversity in research ethics and connected it to inclusiveness in society. The session enabled students to recognize diversity by providing lectures and discussion opportunities on understanding diversity and fairness. Interviews with students indicated that students see a need for this, and student E mentioned,

I think it is necessary. What I remember now is a class given by a Korean teacher. The class was a study on the cognition and consciousness of various people in the society, a study on preconceptions. I think this is necessary.

Student C said,

What impressed me the most was Professor U's [class]. It was a very meaningful and significant class for me to think about how to overcome the difficulties of ethnography and the need to be aware of ethnicity.

In addition, interviews showed that instructors also benefited from this course. Comments and feedback from students in different fields broadened teachers' visions on their own research. According to Instructor U, reading reports written by students from different fields enhanced her understanding of interdisciplinarity. Moreover, Instructor U pointed out that international students' different cultural perspectives of basic concepts and events enhanced learners' and instructors' interdisciplinary thinking.

Interviews also indicated that students of this course learned many ongoing practices and reality from the students who had work experiences. This knowledge, which students cannot learn from textbooks, broadened their understanding of fairness issues in Japan. Student B elaborated that students could learn about the actual situation of special

education for children with disabilities from students working as teachers. Moreover, this course provided working students with new knowledge and references for their works. The interview with Student A showed that this course allows him to accumulate knowledge on fairness issues at a global level and integrate these into his curriculum making and teaching.

Challenges and reflection

There are two major challenges to this course. First, the overall course objectives have space to be further fully understood and shared between students and instructors. It is interesting to note that many students understood the purpose of this class as “interdisciplinary learning” rather than the formation of attitudes toward the creation of a “just and inclusive society.” For example, they specified that the diversity of the class content broadened their visions and helped guide their future research. However, this does not necessarily converge with the objectives of “Edu-fair/fare Mind.” Although students mentioned the course was useful, only a few of them could recognize and explain the original objectives of the course. In addition, interviews showed that students and instructors expected the course to be expanded to student-based teamwork for research collaboration. Currently, this course is limited to knowledge understanding.

The other challenge is to establish a shared understanding of the objectives of this course with the teaching team. According to Instructor U and X, it is better to reach a more explicit consensus regarding the course objectives and the overall course theme. Moreover, instructors must deepen their understanding of the linkages between topics and the course objective of creating an inclusive society through fostering Edu-fair/fare minds. For example, although Instructor U believes that teaching research ethics is vital for researchers to understand diversity, she does not see a clear link between this and issues related to sustainability, such as the construction of inclusive society. In other words, this course can provide opportunities for instructors to reconsider how their research fits into discussions regarding sustainable development. In addition, Japanese language proficiency of international students is a barrier to achieving a mutual understanding of sustainability issues.

Despite the above challenges, Case II suggests that the acquisition of professional and holistic knowledge required by interdisciplinary teaching and learning is likely to be promoted by integrating sustainability issues, such as justice and fairness in teaching and learning, especially in the transition phase from undergraduate to postgraduate study (McEwen et al., 2009; Vermeulen et al., 2014). On the one hand, graduate students could utilize their past disciplinary knowledge to join interdisciplinary learning context. On the other hand, experiences of co-learning of justice/fairness

issues with students from different context (disciplines/background/language/social experiences) activated students to be willing to understand these issues and consider their own research design from different approaches used in other disciplines. Even if the students did not fully develop a common understanding of the purpose of this course, they naturally understood the importance of interdisciplinarity through discussions among diverse members. Therefore, integration sustainability issues, such as justice/fairness, to a regular course for postgraduate students from different disciplines who are in the transition stage to postgraduate study, provides learners the possibility of gaining interdisciplinary awareness.

Discussion

These two cases show how integrating sustainability issues could enhance interdisciplinarity in teaching and learning in non-environmentally related courses at a Japanese research university. By reflecting Biggs’s comprehensive model of teaching and learning in higher education, this section discusses two factors that make the integration of sustainability issues possible and enhance the interdisciplinarity of teaching and learning in non-environmentally related courses at university. Moreover, the analysis of the integration process provides an opportunity to examine which interdisciplinarity are enhanced through integration and interprets what these enhancements mean for teaching and learning in universities.

The first factor for enhancing interdisciplinary teaching and learning by integrating sustainability issues is the diversity of students in knowledge and experiences. Sustainability issues can be a common learning platform for students from different disciplines and backgrounds, which allows students to discuss the issues from different perspectives and share a diverse understanding of the same issues. For example, international students and domestic students with overseas experiences enriched perspectives on sustainability, inclusiveness, and fairness of education in different social contexts, which reflects findings in the existing literature (McEwen et al., 2009). Findings from the postgraduate course indicated that international students could offer new perspectives on understanding of fairness/equity issues. As a result, Japanese students increased their awareness of diversity in understanding of fairness. Moreover, students with work experience described the reality of inclusive education and presented the challenges in an educational sustainability issue to the rest of the students, by sharing their experience in implementing special education at the school.

The second factor is a learning environment characterized by an interdisciplinary faculty team and student-centered active learning. In terms of an interdisciplinary

faculty team, findings from the postgraduate course showed that the sessions taught by instructors from different disciplines provided students with various perspectives to understand sustainability issues. Further, findings from the undergraduate course identified that team-teaching could help instructors teach the course on the global issues related to the SDGs since a such course required broad knowledge beyond their expertise. Carmichael et al. (2017) identify that interdisciplinary faculty team-teaching as a critical learning element of a successful interdisciplinary general education curriculum. Also, findings from the postgraduate course revealed that it is necessary to reach a more explicit consensus among instructors regarding the design and implementation of the course, even though there is an interdisciplinary teaching team. In other words, a shared course design by the interdisciplinary teaching team is key to fully promoting team-teaching for the enhancement of interdisciplinarity (Blake et al., 2013; Spelt et al., 2009).

Regarding student-centered active learning, findings indicate that interdisciplinary skills of students were enhanced in both cases. As mentioned above, in the undergraduate course, students nurtured three skills through interdisciplinary learning: the ability to see from multiple perspectives, the ability to integrate knowledge, and communication skills. Similarly, the postgraduate course showed that through group discussions, students acquired and integrated knowledge of education, psychology, sociology, and anthropology. Students also strengthened their awareness of diversity in understanding inclusiveness and fairness. These are some of the major learning outcomes in interdisciplinary learning identified by existing literature (Ivanitskaya et al., 2002).

Last, we discuss what interdisciplinarity learning outcomes students achieved based on findings from the two cases. To reflect interdisciplinary thinking as learning outcomes introduced by Bigg's model, these cases showed that students enhanced both higher-order skills and communication skills. Case I presented students' development of general skills, such as utilizing multiple perspectives, integrating knowledge, and communication skills. Case II showed that students enhanced their ability to understand educational inclusiveness and fairness, synthesized this knowledge, and strengthened their research ethics and competency. Moreover, students working as teachers adopted the concepts and values of educational fairness and inclusiveness learned during the course to their secondary school education curriculum and teaching. In addition, benefits received from such courses are not limited to students. The two cases also indicated instructors can be inspired by and gain new knowledge from students, which can be meaningful for their research.

Conclusion

By adopting Biggs's framework of the interactive ecosystem of teaching and learning in higher education, this study showed how integrating sustainability issues into non-environmentally related courses as learning topics could enhance interdisciplinary teaching and learning in a Japanese research university. By integrating sustainability issues into curriculums, students and instructors can jointly teach and learn with the purpose of enhancing students' abilities to integrate knowledge from different disciplines and communicate with people with different backgrounds and experiences. Students affiliated with various majors and with different backgrounds and nationalities were able to widen and deepen their understanding of sustainability issues. Also the learning environment, which provides group activities, enhances students' interdisciplinary skills, communication skills, group work skills, knowledge integration skills, and research competencies. Instructors also shared their positive perceptions on combining their expertise with sustainability issues to interdisciplinary teaching and learning. Moreover, the findings showed that instructors' understanding of sustainability issues and interdisciplinary education were enhanced and broadened through communication with students.

However, the findings also unveil limitations in this approach. Similar to previous studies, instructors involved in this study found that they have limited interdisciplinary knowledge to accommodate the needs of students. There is also space to improve team-teaching by building more consensus among instructors in the postgraduate course (Blake et al., 2013). Furthermore, it is necessary to reconsider how to make a more comprehensive connection between the cognitive skill development of students in the regular courses and their daily behaviors and practices. This is closely linked with the target of ESD, which emphasizes acting to transform society.

In conclusion, this study indicates the learning potentials for embedding interdisciplinary education and sustainability education into non-environmentally related courses that had no previous focus on sustainability studies. It also provides references by which to further expand curriculums at a broader scale to better prepare individuals for daily sustainability challenges (Annan-Diab & Molinari, 2017). This approach should be easy to be adopted by comprehensive research universities that already have departments in multiple disciplines. However, it is also necessary to explore an innovative approach to enhancing connections among different departments and disciplines in order to build interdisciplinary teaching teams.

This study identifies the potential for integrating sustainability issues into teaching and learning in higher

education to enhance interdisciplinarity of learners and instructors. More importantly, it reveals the possibility for integrating sustainability issues to teaching and learning in non-environmentally related courses or programs to enhance interdisciplinarity and sustainability competencies of students in universities. Moreover, the study sheds light on implications for enhancing the interdisciplinary skills of students in the transition stages between secondary and tertiary education and between undergraduate and postgraduate education. The findings of this study indicate the possibility of utilizing sustainability issues as a learning catalyst to enhance the interdisciplinary skills of students in universities. In addition, the study shows it is necessary to encourage faculty members from different disciplines in a comprehensive university to join in enhancing interdisciplinary teaching and learning through adopting sustainability issues in Japan and other countries. As for the limitation of this study, we can conduct more extensive scaled surveys on students' learning outcomes in non-environmentally related courses as the case study research cannot fully generalize the whole picture of integrating sustainability issues to teaching and learning. Research on the learning process in interdisciplinary teaching and learning is also helpful for program designers and instructors to understand the limitation of the approaches adopted in interdisciplinary education. Future studies can also create and test comprehensive assessment indicators on learning outcomes of interdisciplinary teaching and learning. Finally, it is necessary to further explore and discuss how to comprehensively strengthen cross-discipline teaching while generating students' and teachers' self-transformation for sustainable development.

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