Article

Teaching the Effectiveness of Integrated Studies and Social Engagement: A Case Study on SDG Education in Depopulated Areas in Japan

Shiori Osanai [1],* and Jeongsoo Yu [1,2]

1   Graduate School of International Cultural Studies, Tohoku University, Sendai City 9800845, Japan
2   Graduate School of Environmental Studies, Tohoku University, Sendai City 9808572, Japan
*   Correspondence: shiori.osanai.p6@dc.tohoku.ac.jp

Abstract: From the 2020 academic year, new courses of study were introduced in Japan, and the necessity of SDG education was newly specified in them. Therefore, in this study, Miyagi Prefectural Shiroishi High School was selected as a case study as it is conducting community-based SDG education in the Tohoku region, which has problems with sustainability, and the educational effects and changes in awareness before and after SDG education were examined. The purpose of this study is to analyze examples of SDG education practice at Miyagi Prefectural Shiroishi High School based on a case analysis of educational practices related to SDGs that clarifies what changes have been introduced to teachers and students via SDG education, and we suggest activities that are beneficial to both teachers and students. The survey was conducted in a questionnaire format before and after SDG education, and a five-point scale was used to confirm the significance of the change. As a result of SDG education, students became interested in social issues in collaboration with local governments, companies, and schools, and teachers were able to cover specialized content that was difficult without any stakeholders.

Keywords: SDGs; education; social cooperation; depopulated area; Japan

1. Introduction

1.1. Background of This Research

The global issues surrounding us are diverse, and to solve them, the universal goal is to reach "Sustainable Development Goals (SDGs)" [1]. SDGs are also regarded as important in the field of education, and education plays an important role in achieving all the goals of SDGs [2]. In the field of education in Japan, teachers have had to work on SDG education because the new curriculum guideline for 2020 stipulates the content of "cultivating creators of a sustainable society". What is important when incorporating SDGs into education is to focus on "Education for Sustainable Development (ESD)".

The importance of ESD toward the achievement of SDGs was mentioned in a UN resolution, stating that "ESD is the key to the realization of all SDGs". The Ministry of Education, Culture, Sports, Science, and Technology explains on its website about ESD as follows.

> "ESD comprises learning and educational activities that aim to develop alternative values and transformative actions that lead to problem-solving and to realize a sustainable society by taking the initiative to accept these problems of modern society as our own and tackling the problems in our immediate environment (think globally, act locally) in order to ensure that human beings are able to secure an abundant life for future generations". [3]

Because the SDGs, which were formulated as issues to be solved in modern society, are achieved by human resources cultivated by its ESD, encouraging leaders to achieve

the SDGs is required. This research focuses on SDG education in the Tohoku region as an example of human resource development that supports a sustainable society. The reason why the Tohoku region is focused upon is because of the high proportion of municipalities with a rapidly aging age composition [4]. Furthermore, the Tohoku region suffered economic damage in addition to the many victims of the Great East Japan Earthquake; the population decreased and depopulation progressed further compared with before the earthquake, and the situation is still not ideal [5].

The importance of SDG education is clearly stated in the new course of study [6], and putting it into practice is not an easy task because it requires dealing with a wide range of topics from the perspective of teacher guidance. There are studies that indicate that teachers lacked knowledge of SDGs before they received training courses [7], and studies suggest that not all teachers are aware of SDGs [8]. Therefore, it is necessary to extract issues regarding SDG education in the field of education from the standpoint of a teacher who conducts SDG education and from the standpoint of the students who receive the education and to consider measures for solving the issues. Therefore, this research analyzed the potential of SDG education via a case analysis of actual SDG education as a means of making rural areas sustainable. There are various theories in the definition of SDG education, but SDG education in this study is practiced within current comprehensive research and refers to education that is centered on the keyword SDGs.

The reason why high school was targeted in this case study is that high school students are the closest to becoming working individuals before higher education, so the educational effect directly affects securing individuals who will lead a sustainable society. High school enrollment is not compulsory education, but according to the 2021 School Basic Survey, the enrollment rate with respect to high school is as high as 98.9% [9]; thus, it is considered highly appropriate to focus on SDG education for high school students.

The reason for focusing on SDG education in Japan is that, although it is a developed country, it is necessary to develop human resources for the younger generation who will support a sustainable society as the country's sustainability is threatened by depopulation and aging in rural areas. This is why it is important to study how a sustainable society can be created from an early stage before entering society. In addition, even though curriculum guidelines require the implementation of SDG education, environmental education, ESD foundations, and educational guidelines that form the basis of SDG education were inadequate [10–12]. As a result, SDGs have not penetrated the field of education. Even if the goal of the SDGs disappears in the future, it is indispensable to examine the current status and issues of SDG education in order to provide education based on that concept.

The purpose of this research is to verify the hypothesis that community-based SDG education has the potential to contribute to human resource development via case studies.

1.2. Literature Review

Environmental education and ESD are related to SDG education. The concept of "environmental education" has undergone a major transformation over the course of decades and has expanded from the narrowly defined concept of environmental education, which mainly focused on nature conservation and conservation and pollution education, to the concept of "sustainability" and ESD [13]. With the changing times, the issues faced by society are changing to be broader and more global, and this background has influenced the transition from environmental education to SDG education.

The content of the SDGs is wide-ranging, and the content of education also varies. This section provides an overview of case studies related to SDG education. As a case in South America, Ecuador is developing public policy within the framework of an environmental education program for the purpose of natural regeneration [14]. A study examining the case studies of sustainable education projects in Bogotá, Colombia, also in South America, features bottom-up ESD with the active involvement of local stakeholders. It has also been shown to promote activities specifically focused on addressing major urban problems in densely populated areas [15].

Looking at SDG education in Southeast Asia, an Indonesian study found that teachers agreed with an education policy that raised awareness with respect to Indonesia's environmental problems, especially the deterioration of the country's atmospheric environment. It was found that student attitudes, social indifference and ignorance, and government implementation were considered challenges in developing environmental education courses in most Indonesian schools [16]. In Indonesia, in addition to various environmental pollution problems such as water pollution, there are many environmental hygiene problems due to the destruction of the natural environment represented by the rapid decrease in tropical forests and the pollution of drinking water [17]. This is why subjects such as pollution education and nature conservation education discussed in Japan from the 1950s are considered to be regarded as important in Indonesia.

Looking at the case studies of SDG education efforts in Sweden, which ranks first in the SDGs' world ranking, as the Scandinavian example, most are aimed at early childhood or elementary school children/students [18–21], and they particularly tend to focus on preschool SDG education and environmental education. While there are many case studies on SDG education and environmental education in early childhood, there are few case studies on SDG education and environmental education in secondary education as far as the findings are concerned. Even in the case of Japan, there are many cases where environmental education is aimed at elementary school students, but there are also cases where secondary education focuses on comprehensive study time. However, in Sweden, there is no specific subject on environmental education, and each subject is obliged to discuss an aspect of environmental education [22]; thus, it is not considered to be within the framework of SDG education and environmental education. It can be inferred that there may be practical examples in compulsory education. It can be said that Sweden and Japan have in common that there is no specific subject of environmental education and that each subject discusses an aspect of environmental education. In addition, Lgy 11 (Curriculum of Higher and Secondary Education) [23] does not provide a clear definition of sustainable development (SD) and is addressed in the "Basic Values and Challenges" section of Swedish schools for globalization and internationalization, as well as other areas such as democracy, gender, health, identity, cultural diversity, and lifestyle issues [24]. From these facts, education in Sweden focuses more on the subjects dealt with locally than on the SDGs.

Global citizenship education (GCE) emerged as a prominent issue in South Korea, which shares social issues with Japan, and South Korea is now involved in sustainable development goals (SDGs) with the influx of immigrants. It turns out that they are facing international demands [25]. The South Korean government is also focusing on sharing SDG education experiences with developing countries as part of its international development-related efforts [26]. From these contents, it can be observed that South Korea is also focusing on GCE as an international and external initiative for SDGs. As mentioned above, the influx of immigrants emerged as a prominent problem, and it is predicted that South Korea will become a super-aged society by 2030, with South Korea's elderly population accounting for 24.5% of the total population [27]. In addition to the declining birthrate and aging population as in Japan, the population is increasing in each wide-area city other than Busan, while the population is declining in small cities [28]. South Korea has a social background that is very similar to that of Japan. Therefore, it is considered that South Korea is examining its sustainability by cooperating with and educating foreigners. Because education is expected to have a long-term effect, it may have adopted a policy of maintaining the sustainability of the nation with the help of immigrants by introducing international civil education. On the other hand, with respect to SDG education in Japan, there are no studies on international and external educational efforts as far as the findings are concerned. This difference is due to the difference in policies; while Japan attaches great importance to improving the sustainability of each region, South Korea emphasizes improving sustainability by training human resources who fly in from other countries, such as immigrants.

The comprehensive findings of previous studies show that the perception of SDG education differs depending on the circumstances of each country. The problems of declining birthrates, an aging population, and depopulation, which are currently problems in Japan and South Korea, will potentially be faced by all countries in the process of becoming developed countries. Therefore, there should be a focus on SDG education in regions where the sustainability of the region itself is vulnerable, and its effects are an important issue that should be explored in order to create a sustainable society in the future.

In Japan, as a case of SDG education, there is a case where a visiting lecture was given on plastic recycling and waste issues as part of the reconstruction support for the disaster area caused by the tsunami damage of the Great East Japan Earthquake [29], and the SDGs themselves attract substantial attention, such as being mentioned in the new course of study, but there are few studies that have verified their effects as educational cases. Research on SDG education only began about six years ago, and it is difficult at this point to generalize the characteristics of SDG education efforts in each country. Therefore, it is not easy to state what the position of SDG education is in Japan compared with the international position. The SDG education case mentioned in this study was also investigated and analyzed as an example of a characteristic initiative in Japan, but hints that can be referred to in similar areas facing a declining birthrate, aging population, and depopulation are provided.

From the examples of SDG education in each country, we learned that there are various approaches and target ages depending on the social background and issues. That is why it is not possible to generalize and discuss SDG education in each country based only on previous research reviews.

In addition, in research on SDG education, there is a study that evaluated the scope of SDG application in the learning outcomes of a master's course [30], and another study examined the type of social issues that university students in the third year of early childhood education are interested in [31]. Another study analyzed how learning about social responsibility (SR) changed college students' perceptions of the importance of responsible corporate behavior [32]. There is also research focused on Slovenian and Austrian biology student teachers' understanding of education for sustainable development (ESD) and sustainable development (SD) [33]. Another study found that students at the University of Graz, Austria, felt the importance of future-oriented topics and content on education for sustainable development [34].

Therefore, the originality of this research is to focus on the Tohoku region, where the population is rapidly declining, and to focus on the changes in students and teachers via comprehensive SDG research activities that go beyond subject education as a clue to solving the problem. As mentioned above, many studies that incorporate the SDGs in the context of education target students at universities and graduate schools. Moreover, in a previous paper, the author investigated the current status and challenges with respect to efforts that integrate sustainable development goal (SDG) education into the Japanese high school curriculum and conducted a questionnaire survey to understand teachers' awareness of SDG education [35]. The study clarified the difficulty of SDG education practice but did not clarify whether there was an educational effect attained via SDG education. Therefore, in this study, we clarify the effects of SDG education on both teachers and students via a case study.

1.3. Sustainability of Regions as Seen from Regional Characteristics Based on Net Population Growth Rate in Japan

In this section, the sustainability issues that Japan faces today are presented to clarify why the schools in the Tohoku region were chosen for the study. The section shows how the demographics of each region in Japan have changed over the 10 years since 2010 and how the Tohoku region is in a critical situation in terms of population decline. After that, the state of SDG education practice in the Tohoku region, which is strongly affected by depopulation and aging, will be described.

The problem Japan faces is that of regional sustainability. Japan's elderly population rate is 29.1%, which is the highest in the world, and in 2021, the total population of Japan decreased by 510,000 compared with the previous year. On the other hand, the elderly population aged 65 and over in 2021 reached 36.4 million, which is an increase of 220,000 compared with the previous year and was the highest ever [36]. According to the Ministry of Internal Affairs and Communications, from the fiscal year of 2022, the number of municipalities where all or part of the municipality has been designated as a depopulated area is 885, and this figure is 51.5% of the total number of municipalities nationwide [37]. This is the first time that the number of depopulated municipalities has exceeded 50% of the total number of municipalities since the act on Emergency Measures for Depopulated Areas was enacted in 1970 [38]. Based on the above-mentioned content, regional revitalization measures have not put brakes on the decline of the regions. On the other hand, the Japanese government wants to achieve regional revitalization via SDG initiatives. As a basis for this, Japan emphasized the following four initiatives in the SDG Implementation Guidelines of the SDG Action Plan 2021: (1) infectious disease countermeasures and preparations for the next crisis; (2) growth strategies through business and innovation for better reconstruction; (3) regional revitalization and environmentally friendly and resilient urban development driven by the SDGs; and (4) the acceleration of action via the demonstration of individual potential and the strengthening of bonds [39]. Regarding the problem of population outflow, JILPT (2016) clarified via research that the main reason people move from their hometowns to other regions is to move to university, vocational school, etc., or to find employment, and it was also pointed out that 18-year-old individuals accounted for the largest proportion of individuals that move to other regions [40]. As mentioned above, one of the causes of population decline in the region is when people move out at the age of 18; thus, high school students in regions with declining populations must raise their awareness of the issues facing the region via SDG education that is rooted within the region.

One of Japan's sustainability issues is the depopulation of rural areas. Therefore, the regional characteristics of each of the seven regions—Hokkaido/Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, and Kyushu—were analyzed from the perspective of the net population increase–decrease rate. In this section, the reason why this research study focused on the Tohoku region is clarified. In Japan, a national census is conducted every five years. The census data dealt with here comprise 10-year data from 2010 to 2020 [41–43]. In order to grasp the demographics, this study focused on the net population increase–decrease rate over the ten years from 2010 to 2020. Then, in order to clarify the regional characteristics more clearly, all municipalities in Japan were ranked by their net population change rate, with the top third in Group A, the middle class in Group B, and the bottom third in Group C. What can be shown from this is that Group A has a low rate of population decline, Group B has a moderate rate of population decline, and Group C has a high rate of population decline. The sustainability of the area worsens from Group A to Group C. Looking at Figure 1 and based on this assumption, the Hokkaido and Tohoku regions account for 38% of Group C, and it can be observed that the Hokkaido and Tohoku regions have the worst sustainability in terms of population decline in Japan. For this reason, this research focused on the northern part of Japan, which is in the most critical situation, and selected high schools in the Tohoku region as the subject of the case study. In this study, Hokkaido was not included in the target area. The reason for this is that although Hokkaido is a single prefecture, it has the special characteristic of having the same number of local governments as a single region. For example, Hokkaido has 179 municipalities, and the Chugoku region has 107 municipalities. While Hokkaido is a single prefecture, the Chugoku region is made up of five prefectures (Tottori, Shimane, Okayama, Hiroshima, and Yamaguchi). As a characteristic of each region in Japan, it was shown that the northern part of Japan has more problems with sustainability. Moreover, in the reconstruction of local communities after the Great East Japan Earthquake, there is not only the direct damage caused by the disaster but also the secondary issue of dealing with population decline due to the migration of residents [44]. In this way, it can be observed that the sustainability of

the Tohoku region has become fragile due to the overlap of various factors. In the next section, the actual situation of SDG education efforts of full-time public high schools in the Tohoku region is shown, and the validity of choosing Miyagi Prefectural Shiroishi High School as the target school for the case study in this study is indicated.
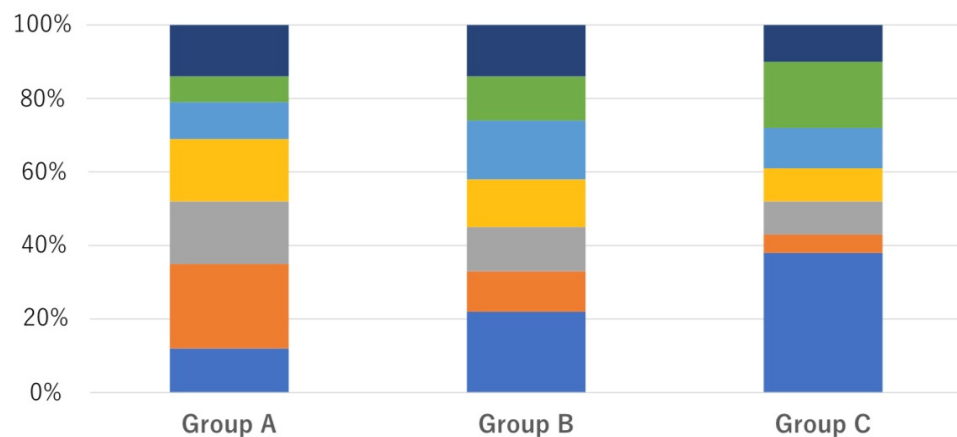

Figure 1. Group A, Group B, and Group C: regional breakdown in each group.

1.4. SDG Education in Tohoku Region

As was mentioned in the introduction, the new Japanese course of study introduced in 2020 clearly states the necessity of implementing ESD in relation to SDGs. In this research study, we focus on the SDG education practice case of Miyagi Prefectural Shiroishi High School, which is located in the Tohoku region. The Tohoku region is a region with substantial problems including declining birthrates, an aging population, and depopulation; thus, the region itself has problems with its sustainability. In the current situation where the Japanese government has also indicated the importance of regional revitalization, there is a problem with regional sustainability in the Tohoku region. That is why SDG education in the Tohoku region is of great significance as human resource development that supports the sustainability of the region. Therefore, this section presents the results of a survey of the implementation status of SDG education at public high schools in the Tohoku region as of 2020. As of 2020, the number of public high schools (full-time) in Tohoku was 370, and of the 370 schools, 57 reported that they were conducting SDG education. This indicates that 15.4% of all high schools in Tohoku are providing SDG education. The content of the activity has two characteristics. The first feature is the one-off basis educational activities such as lectures and external seminars. The second is continuous education efforts. Continuous education is a class or extracurricular class, and the main one is a research activity class that takes place throughout the year. Of the 57 schools that provide SDG education, only 12 continue to engage in SDG education, accounting for 3.24% of all high schools in the Tohoku region.

Most high schools that deal with SDGs in continuous learning deal with themes rooted in school districts and departments. Among them, two schools, Miyagi Prefectural Shiroishi High School and Fukushima Prefectural Fukushima Nishi High School, handle a wide range of themes from the SDG items. Those two schools also have in common that they use a syllabus to deepen their learning about the SDGs throughout the two years. In addition, both schools summarize and present educational activities throughout the year, such as essays and posters, and are working on SDGs by incorporating project-type learning. However, Miyagi Prefectural Shiroishi High School has been working on SDG education since 2018 and conducts SDG education one year earlier than Fukushima Prefectural Fukushima Nishi High School. In this regard, Miyagi Prefectural Shiroishi High School is working as a pioneer in SDG education in the Tohoku region, and it is expected that more mature SDG education will be carried out.

In addition, Miyagi Prefectural Shiroishi High School's SDG education was published on the website of the Ministry of Education, Culture, Sports, Science, and Technology as a good example of SDG education in Japan [45], and it was also published in the Nikkei Newspaper as a good example [46]. Furthermore, in 2021, when the SDG education initiative was in its third year, the "Biodiversity Promotion Activity Excellence Award" was commended by the Governor of the Miyagi Prefecture and the Governor of the Murai Prefecture in recognition of its pioneering efforts [47]. As a result, it is attracting attention both within the Miyagi prefecture and nationwide.

Therefore, in the next section, we will examine the effects and discuss SDG education methods while examining practical examples of Shiroishi High School's research activities that are related to SDGs as specific examples of SDG education.

2. Materials and Methods

As a research method, I went to Miyagi Prefectural Shiroishi High School and participated in the actual SDG education site (high school–university collaborative activities, exchange of opinions with leader teachers, and confirmation of advice/annual guidance plan). Miyagi Prefectural Shiroishi High School is a full-time three-year public high school, and there are two courses provided: a regular course and a nursing course. A total of 515 first- and second-year students participated in SDG research activities, of which 269 were first-year students and 246 were second-year students. Also, first-year students are 15 to 16 years old, and second-year students are 16 to 17 years old. There are 34 teachers involved in SDG research activities, and these teachers are also survey subjects. In SDG research activities, the first and second grades of these two courses explored topics related to SDGs. In research activities, students think about issues related to sustainability, and students with common interests form groups and work together to come up with ideas for solving the issues. At the beginning of April, the students are divided into groups, and each group works on a research project on a set SDG-related topic in preparation for announcing their results in January. From May onwards, each group will start researching literature and materials in order to set more specific issues and propose solutions. In addition, teams that require fieldwork or experiments, such as water quality surveys, create plans for that purpose. The progress of each group was confirmed at the interim presentation in October, and opinions were exchanged with all teachers and stakeholders that cooperate with students' research activities. The students of each group received advice from teachers and partners participating in the interim presentation, and then faced the final presentation in January. The content of the research activities related to the SDGs here is to conduct research assignments including investigative learning, fieldwork, experiments, etc., and to present the research results at the final presentation. The students were divided into 59 groups, and each group conducted research activities related to SDG items that they were interested in. Because we could not obtain poster data for 3 of the 59 groups, we calculated the percentage of the survey area from the poster data for 56 groups. As a result, 49 out of 56 groups (87.5% of the groups) set Japan as the target area for the survey, and 46 groups out of the 49 groups (93.88% of the groups) that set Japan as the survey target area set Shiroishi City as the survey target area. In other words, 46 out of 56 groups (82.14% of the groups) set Shiroishi City as the survey area. Not only did the survey use the Internet, but depending on the content of the survey, students went to a local private lab to conduct experiments, and the students held a festival with the cooperation of the local city hall; there was also a group that went to listen to lectures on specialized content from university professors. While responding, giving advice, and attending the interim presentation and the final presentation (advice/general comment), we considered the educational methods of teachers and the efforts of students. The process and contents of creating poster data as a deliverable were analyzed, and a questionnaire survey was given to teachers and students regarding educational effects. A content analysis of the poster data was conducted to find out which SDG items each group dealt with as the main theme of their research activities. Based on this result, we clarified which SDG item among the 17 items students

were most interested in [35]. The questionnaire was sent by mail on April 1, 2020, and it was collected by mail on May 28, 2020. The outline of the questionnaire asks questions about changes in students' social consciousness, changes in the degree of knowledge and understanding of teachers' SDGs, and changes in teachers' motivation for the guidance of SDG research activities before and after SDG research activities. The cases dealt with in this research are research activities related to the content of the SDGs in general. Therefore, the content indicated by the word "SDGs" that appears in the questionnaire is the SDGs in general. In the context so far, the depopulation of rural areas and the declining birthrate and aging population have been viewed as problems, and the importance of achieving regional revitalization has been mentioned. However, this research does not focus only on specific SDG items related to regional revitalization. As mentioned above, although the SDG items to be focused on differed for each group, 82.14% of the groups selected Shiroishi City as the target area for their research activities. What this means is that although the themes of inquiry activities adopted by the students are wide-ranging, such as the reuse of clothes and the water quality survey of rivers, more than 80% of the groups conducted surveys related to Shiroishi City. For this reason, in the survey of this research, SDGs are indicated as the meaning of SDGs in general in the context of discussing regional revitalization. When answering questions, the subject answers the questionnaire by choosing the option that most closely matches the subject's ideas. Details of the questions asked in the questionnaire will be presented in the survey's results. Moreover, the analysis software used to compare the results of changes before and after SDG research activities and to test their significance was Excel, and the test method was the McNemar–Bowker test [48], which is a correspondence test. In the questionnaire of this research, we adopted a 5-point evaluation, but McNemar's test can only compare binary pair data; thus, to compare 5 items, McNemar–Bowker tests were adopted, which can compare the data on 3 or more items. The McNemar–Bowker test method was used, but the population parameter of the subjects was small, and there were some 0s in the cells of the data. Therefore, using the nominal symmetry test [49], five items on a five-point scale were compared for each item. This means that Neutral is also statistically analyzed by the nominal symmetry test. The 5-point scale consists of 5 items: very much, quite a lot, neutral, a little, and not at all. As a procedure for the test, the results of the consciousness survey obtained by the 5-grade evaluation before the research activity and the results of the attitude survey obtained by the 5-grade evaluation after the research activity were compared for each item, and the nominal symmetry test was conducted. This test method was used to examine whether the null hypothesis was rejected. "Students' awareness of problems in modern society becomes stronger after conducting SDG research activities than before", "Teachers' knowledge and understanding of the SDGs will deepen after conducting SDG research activities rather than before conducting them", and "Teachers feel the need for SDG research activities more after conducting them than before" are the hypotheses of this study and the criterion for rejecting the null hypothesis is a p-value less than or equal to 0.05 with a significance level of 0.05. An interview was also conducted with two teachers who led this SDG exploration activity. These two teachers are the leaders who planned and managed the SDG research activities at Shiroishi High School. Although the sample size of these two teachers is small, in this study, the contents of the interviews with these two teachers were used as additional information for considering the questionnaire results. In this interview, we asked about the differences in the way of thinking about SDG research activities between the 1st and 2nd graders and asked the two teachers to talk freely.

As mentioned above, changes in students and teachers before and after the research activity were investigated. From here on, the outline of the research activities will be explained in order to clarify what kind of research activities brought about the change. In research activities, students are divided into groups according to areas of interest in the SDGs, and experiments, fieldwork, literature research, etc., were conducted in order to derive ideas for solving issues related to that area. Within the research activities, local governments and companies, universities in the Tohoku region, and local citizens and

schools collaborated, making it possible to carry out more realistic and authentic research activities. In these research activities, students are naturally given the opportunity to learn about the local area, as the research was conducted in collaboration with local stakeholders.

3. Results

First, the results of clarifying which of the 17 SDG items students are most interested in by analyzing the content of the poster data are shown. Multiple groups adopted multiple items of the SDGs. Among SDG items No. 1 to No. 17, the most adopted SDG items were No. 3 "GOOD HEALTH AND WELL-BEING" and No. 11 "SUSTAINABLE CITIES AND COMMUNITIES", each of which was adopted by ten groups, and the next most adopted SDG items were No. 1 "NO POVERTY", No. 6 "CLEAN WATER AND SANITATION", and No. 13 "CLIMATE ACTION", each of which was adopted by six groups [35]. This suggests that there are many students who are interested in health and livable communities.

Students in grades 1 and 2 were investigated to see if they became interested in the problems of modern society via taking part in SDG research activities. Figure 2 shows whether students had knowledge of SDGs before the SDG research activity, and Figure 3 shows the changes in consciousness before and after the SDG research activity.
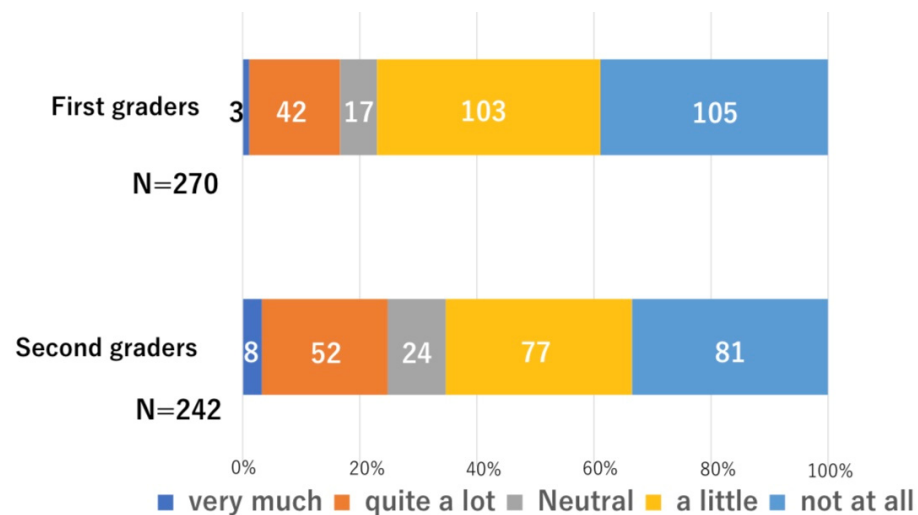

Figure 2. Whether the students had knowledge of SDGs before the SDG research activity.
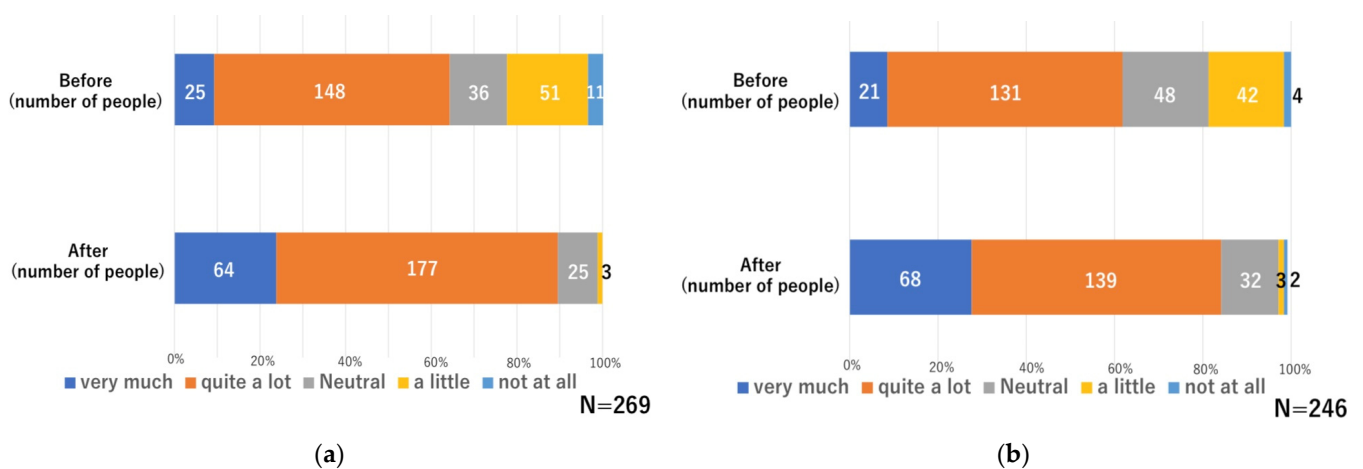

(**a**)

(**b**)

Figure 3. (**a**) shows the awareness of problems regarding modern society before and after SDG research activities in grade 1, and (**b**) shows the awareness of problems regarding modern society before and after SDG research activities in grade 2.

Grade 1 and 2 students were asked whether they became more aware of the issues of modern society after the SDG research activity than before. Changes in student consciousness before and after SDG activities were examined using nominal symmetry tests. As a result, $p = 0.0001 \leq 0.05$ for both the first- and second-grade students. Therefore, the result was that there was a significant difference due to the rejection of the null hypothesis. This result suggests that SDG research activities can be understood as being very effective in stimulating students' awareness of problems and raising their interest in society. It is expected that more students will become more aware of the problems in modern society by conducting SDG research activities. Even after the activities of the SDGs, two students in the second grade said that they had no interest in the social situation. Therefore, it is considered that the second grade itself tends to be less interested in the social situation than the first grade. In the interview, it was found that second-year students were enrolled on the premise of receiving work experience as a comprehensive learning effort. On the other hand, the first graders are the students that have been enrolled on the premise of conducting SDG education as an initiative for comprehensive study time. This tendency is not surprising because it became clear that the first graders were more interested in social issues, etc., as a sense of purpose when they enrolled. Although the trends in each grade are different, it can be said that the SDG research activity has the effect of stimulating students' awareness of problems and raising their interest in society, as significant results were obtained in both the first and second grades.

Furthermore, Figure 4 shows whether the teachers deepened their knowledge and understanding of the SDGs before and after their research activities.
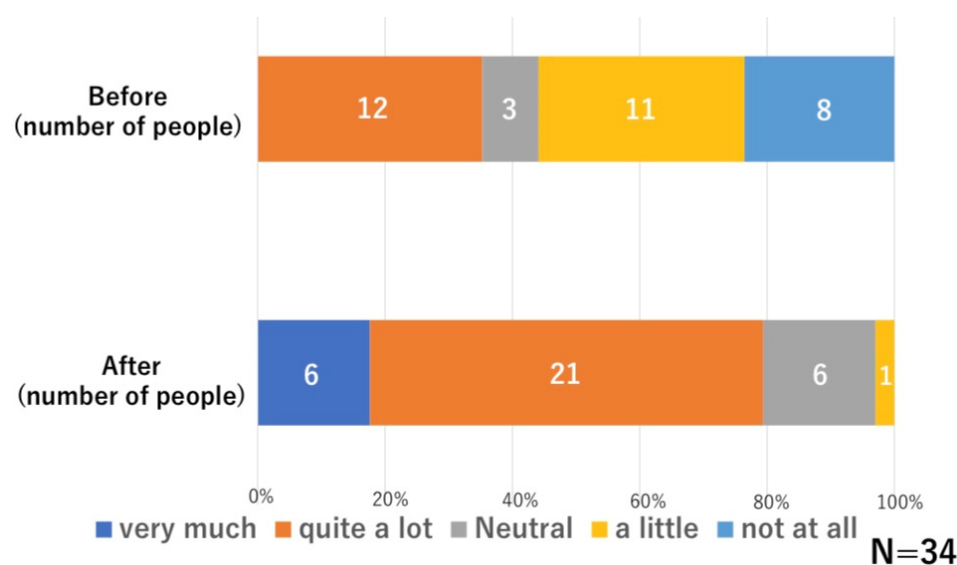

Figure 4. Comparison of the knowledge and understanding of SDGs acquired by teachers before and after SDG activities.

Using the nominal symmetry test to examine whether or not the teachers' knowledge and understanding of SDGs were deepened after the SDG research activity, the result was $p = 0.0001 \leq 0.05$. The result was that there was a significant difference by rejecting the null hypothesis. This result suggests that the teachers themselves deepened their knowledge and understanding of SDGs via the guidance of research activities and via the guidance of SDG research activities.

Figure 5 shows the results of asking teachers whether they felt the need for SDG research activities. Using the nominal symmetry test to examine whether teachers felt there was a need for SDG research activities after the SDG research activities, the result was $p = 0.0001 \leq 0.05$. The result was that there was a significant difference by rejecting the null hypothesis. This result suggests that a deeper understanding of the SDGs in the form of

guidance in research activities led to an increase in the number of teachers who think that SDG education is necessary.
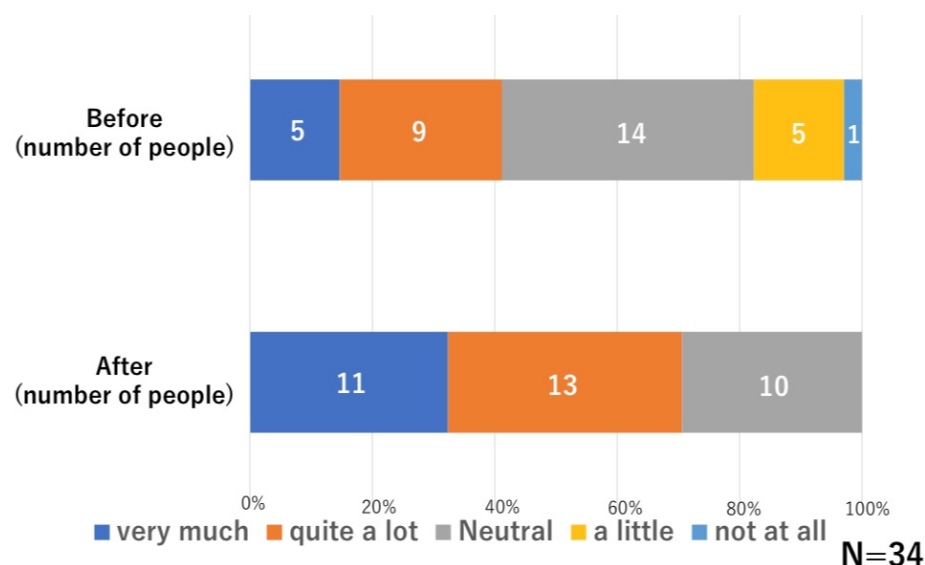

Figure 5. Changes in teachers' awareness of the need for research activities before and after SDG research activities.

In addition, it became clear that all the teachers who conducted the questionnaire felt a lack of knowledge about their own SDGs, which they found difficult when conducting SDG education. Miyagi Prefectural Shiroishi High School uses a method of conducting SDG education not only with schools but also with local partners, and this method is utilized as one of the measures for solving difficulties when actually conducting SDG education. Therefore, teachers were asked to rank the collaborators who actually collaborated from their perspectives.

Teachers at Miyagi Prefectural Shiroishi High School were asked to rank collaborations that were considered to be particularly useful in the SDG research activities from first to third place. Then, the score was calculated with three points for the first place, two points for the second place, and one point for the third place, and the overall ranking was decided. There are five options presented: (1) cooperation with local companies, (2) cooperation with local governments, (3) cooperation with local citizens, (4) cooperation with universities, and (5) others. Those who chose "Others" were asked to choose the cooperation method that they thought was good while providing a free description. The examples of the collaboration methods that were good for those who chose "Others" were "Collaboration with small stores that are engaged in SDGs-related efforts" and "Interviews with experts". The overall ranking is shown in Table 1. The score calculation is as follows.

Score = (1st place number of people × 3 + 2nd place number of people × 2 + 3rd place number of people × 1)/5 item total score × 100

First, it is stated that cooperation with the top three "universities", "local governments", and "local companies" was useful. This result may suggest the possibility of interdisciplinary exchanges in collaboration with universities, local governments, and companies in high schools. Table 2 shows the results of asking teachers about the merits of collaborating with local communities and universities in order to consider what type of collaboration method should be used to obtain higher effects in SDG research activities from the perspective of teachers. The students stated that it was good that they cooperated with other entities, and the order ascended from "local government", "local company", to "university" in both the first and second grades. From this observation, it can be observed that the students agreed with the cooperation method that the teachers also felt was useful.

Table 1. Ranking of partners that were particularly useful in SDG research activities.

Ranking	Teachers	First-Grade Students	Second-Grade Students
1	Collaboration with universities (score 32)	Cooperation with local government (score 31)	Cooperation with local government (score 30)
2	Cooperation with local government (score 26)	Collaboration with local companies (score 27)	Collaboration with local companies (score 28)
3	Collaboration with local companies (score 25)	Collaboration with universities (score 22)	Collaboration with universities (score 23)

Table 2. The reasons why teachers think that cooperation with the region (local companies/municipalities/local citizens) and university was useful (multiple selections allowed).

I was able to provide fieldwork that could not be realized at school.	34 (100%)
I got an opinion from a different perspective than us.	22 (64.71%)
The motivation of the students has increased.	14 (41.18%)
I was able to provide experiments, etc. that are conducted with equipment that is not available at the school.	7 (20.59%)
The burden of preparation has been reduced	3 (8.82%)
Others	1 (2.94%)

As for the items that helped in the collaboration with the community and the university, all teachers chose the item "I was able to provide fieldwork that could not be realized at school." In the second place, 22 teachers, 64.71% of the total, selected the item "I got an opinion from a different perspective than us." In addition, as shown in Table 3, all 34 teachers chose the option "I didn't have enough knowledge about the SDGs" when asked about the difficulties they faced in guiding SDG research activities. It is difficult for teachers to provide guidance while covering the 17 items of the SDG achievement goals with their own knowledge. Therefore, working with researchers who are experts in research related to the SDGs and other companies makes up for the lack of knowledge of the teachers. It is expected that such industry–academia collaboration will lead to the deeper learning of SDG learners.

Table 3. Points that teachers found difficult when conducting SDG education (multiple choices allowed).

I didn't have enough knowledge about the SDGs.	34 (100%)
Students were not highly motivated.	20 (58.8%)
Insufficient teaching time and poster making time.	18 (52.94%)
I was not confident in teaching SDGs research activities.	15 (44.12%)
There was not enough material to do the research.	11 (32.35%)
others	8 (23.53%)

4. Discussion

The research study was conducted based on three pillars: an analysis of previous research on SDG education, an analysis of the actual situation in Japan from the perspective of demographics, and an analysis of the educational effects of SDG research activities at Miyagi Prefectural Shiroishi High School. Previous studies on SDG education mostly consist of case studies, but since the SDGs cover a wide range of topics, generalized discussions were not easy. However, the characteristics of SDG education differed due to the challenges faced by each country. For example, if environmental pollution is a problem, the SDG items that lead to a solution were picked up within the context of SDG education. Japan and South Korea share common challenges, such as depopulation and aging in rural

areas. Japan placed more emphasis on solving problems domestically, while South Korea placed more emphasis on solving problems with help from foreigners, such as immigrants. As issues related to sustainability in Japan, the declining birthrate, aging population, and depopulation in rural areas were raised. Although the issues facing each country are different, the same can be said for each region. Since the case study focused on in this study was the case of SDG education at Miyagi Prefectural Shiroishi High School, it was suggested that the issues faced by Shiroishi City in Miyagi Prefecture, which is located in the Tohoku region, directly affect the content of SDG education. Of course, not all of the students in this case researched the depopulation of rural areas due to population decline, the declining birthrate, and an aging population. However, it was observed that more than 80% of the students selected Shiroishi City as the survey target area and sought to improve the area in some way. Comprehensively considering the above-mentioned contents and what was found in the previous research review, it is considered that the problems faced by the area may affect the interests of the young generation living there. Based on data from the National Census from 2010 to 2020, the net population increase–decrease rate of each municipality was calculated and ranked with respect to three levels. An assessment of the current situation in rural areas revealed that the population is declining significantly in the northern part of Japan. Particularly in the Tohoku region, it was found that the Great East Japan Earthquake accelerated the outflow of population from Tohoku to other regions. The Miyagi Prefectural Shiroishi High School, which was among the first in the Tohoku region to start community-based SDG education, conducted SDG research activities related to regional issues in collaboration with local stakeholders. A content analysis of the poster data revealed that SDG items 3 and 11 were most frequently selected by students, suggesting that students are more interested in health and in livable areas [35]. In addition, considering the fact that more than 80% of the groups selected Shiroishi City as the target area for the survey and the above-mentioned content, it is clear that although students have different interests in SDG items, it is speculated that there may be a desire for certain areas to become healthier and more livable. As an educational effect, students' awareness of social issues was improved. The SDG research activities in collaboration with local stakeholders were effective not only for the students but also for the teachers. It was observed that by being involved as instructors, teachers not only deepened their knowledge and understanding of the SDGs themselves but also became more aware of the need for SDG education, such as SDG research activities. In this case study, all teachers felt that they lacked knowledge about the SDGs. It can be observed that the provision of specialized knowledge from local universities, companies, and local governments deepened the teachers' understanding of the SDGs and increased their motivation for SDG education. Even in areas facing depopulation due to the declining birthrate, schools and community stakeholders work together to make the most of their respective fields of expertise and carry out research activities to solve local issues, which stimulates students' awareness of problems, deepens teachers' knowledge understanding, and motivates them to teach related topics.

The purpose of this research was to verify the hypothesis that community-based SDG education may contribute to human resource development using case studies. In this study, both students and teachers were able to see the effects of implementing SDG research activities in cooperation with local stakeholders and schools. However, the declining birthrate, aging population, and depopulation in rural areas cannot be resolved in an instant just because people are more aware of the issues facing their communities and have a deeper understanding of the SDGs. It will take time for the long-term effects of education to become visible and observable, but there is no doubt that deepening the teachers' knowledge and understanding of the SDGs and increasing their motivation for teaching SDG education will have a positive impact on the development of young human resources: the students themselves. Furthermore, in response to the fact that students' awareness of social issues has improved via SDG research activities, it was suggested that SDG education

can stimulate young people's awareness of social issues and provide an opportunity to find clues to solutions.

5. Conclusions and Future Tasks

It was suggested that, through the SDG inquiry activities at Miyagi Prefectural Shiroishi High School, the students became aware of social issues. In short, SDG research activities have the potential to produce students who are more concerned and aware of social issues. In addition, both students and teachers felt a lack of knowledge about the SDGs, and teachers found it difficult to teach SDG research activities. On the other hand, research activities on SDGs had the effect of deepening the knowledge and understanding of not only students but also teachers about SDGs.

In addition, teachers were able to acquire new knowledge and perspectives not only through on-campus learning but also through external collaboration. Conducting research activities in collaboration with institutions outside the university has the potential to expand the knowledge of the SDGs for students as well as teachers. The above highlights the positive impact schools can have on research work on a wide range of topics, including SDGs, in collaboration with local stakeholders.

By conducting this research, the development of SDG education at Miyagi Prefectural Shiroishi High School and the attitude of students and teachers toward SDG education have been clarified. Incorporating data from many public high schools nationwide is an issue for the future. In addition, the area around Shiroishi is currently depopulating, but from the perspective of "regional revitalization", it is believed that the active role of students as human resources that can support the area in the future will help stop depopulation. Therefore, I would like to clarify a concrete vision for the future of students and the region by examining how the future education of students has changed via SDG research activities.

In addition, in previous research, examples of SDG education in higher education institutions were cited. It is considered that deepening the knowledge and understanding of SDGs while still in high school and gaining an opportunity to become interested in social issues are both meaningful methods in the modern period, when more than half of high school students move on to institutions of higher learning such as university. Since this study focused on one high school case, there are limits to generalizing this result. However, via the SDG research activities, activities for finding solutions to the issues were conducted, and the positive impact not only on the students but also on the teachers was examined. This study's outcomes were able to present educational methods that various schools can refer to when working on SDG education in the future. Since a follow-up survey is necessary to observe the educational effects from a long-term perspective, it is not possible to completely say whether SDG education contributes to regional revitalization based on the survey and analysis results of this research. However, it is thought that the results of this study also suggest the potential for developing human resources that will contribute to a sustainable society. In this study, the SDG items of high interest among the students at Miyagi Prefectural Shiroishi High School were indicated, but the SDG items of high interest of teachers were not indicated. In addition, this research examined how the SDGs in general are perceived, regarding what kind of role SDG education contributes to regional revitalization. However, since there are 17 SDGs and each includes different content, a more detailed analysis by categorizing them will be necessary in the future. In this paper, these are the limitations of this research.

A 10-year demographic analysis shows that the rate of population decline was high in the northern part of Japan. In particular, the Tohoku region was not only hit economically by the Great East Japan Earthquake but the event also accelerated its population's outflow. Japan is an island nation that is prone to earthquakes and is the country with the highest aging population in the world. Even in countries with such fragile foundations, it is hoped that dealing with the SDGs in the context of young human resource development will motivate young people to think about a sustainable society themselves.

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