A new partnership framework for education with geoparks at its core: a proposal through the evaluation of the school education program in Shikaoi, Japan

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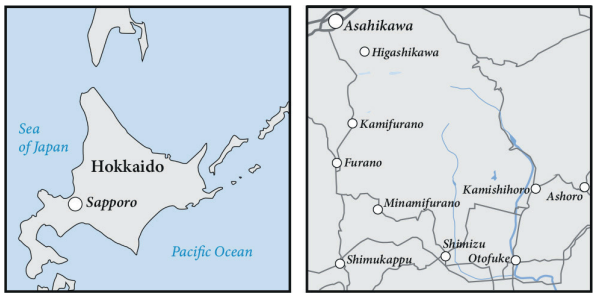

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Abstract: *The primary objectives of geoparks are to conserve geoheritage, enhance public awareness and understanding of geoscience, and drive sustainable economic growth in local communities. Education acts as the cornerstone in achieving these three objectives, as it provides the necessary foundation for their realization. This study proposes a new educational framework to promote the sustainable development of geoparks by evaluating the effecacy of the past geoeducation program. Specifically, this study focused on the Tokachi-Shikaoi Geopark and Hokkaido Shikaoi High School. A mixed methodology was employed, including content analysis of the textbooks, online questionnaire surveys of high school students, and field interviews with key informants. The results revealed that while geoeducation with well-prepared textbooks was encouraged in schools in Shikaoi Town until 2018, there is a need to revitalize geopark education in an alternative way for the future. We proposed a new partnership framework for the educational program among the geopark, universities, elementary, junior high, and high schools, and other stakeholders to maximize the geopark resources in the proposed program through the effective use of existing textbook assets. The results of the questionnaire surveys found that not only indoor learning with textbooks, but also outdoor learning at geosites is important. The results of the interview survey suggested the need to offer training and support for schoolteachers. To address budget constraints, this study proposed the inclusion of support from universities and the introduction of e-textbooks featuring geopark-related knowledge. This study highlights the crucial role of education in promoting sustainable development in Tokachi-Shikaoi Geopark. The insights gained have broader implications for education in other geoparks, offering valuable guidance for enhancing the quality and effectiveness of education in geoparks.*

Keywords: *geopark, geoeducation, sustainable development, partnership, Japan*

Introduction

As defined by UNESCO, geoparks are unified geographical areas where sites and landscapes of international geological significance are managed through a comprehensive approach to protection, education and sustainable development (UNESCO, 2016). The Global Geoparks Network (GGN), administered by UNESCO, recognizes national geoparks worldwide (GGN, 2022).

Education for sustainability, along with geoconservation and geotourism, is one of the three core elements of any geopark (Zouros, 2004; McKeever & Zouros, 2005; Stoffelen *et al.*, 2019; Catana & Brilha, 2020). All UNESCO Global Geoparks implement educational activities targeting all age levels to promote an understanding of geological heritage and its connections with other natural, cultural and intangible heritages (UNESCO, 2016). Through education, geoparks enhance local awareness of the area's geological

heritage in history and society today, instilling regional pride and strengthening local identification (Shahhoseini *et al.*, 2017). Moreover, geoparks contribute to educating visitors about the region's natural history (Ríos *et al*., 2020) and support sustainable development within local communities (Takenouchi, 2016). Education and the popularization of science are important components of the diverse educational activities conducted in geoparks for all population groups (APGN, 2022).

Geoparks typically educate the public on knowledge on geology and environmental concepts through various means such as museums, information centers, guided tours, school programs, maps, educational materials, and seminars. This engagement in educational activities, both formal and informal, instills the importance of sustainable development in young students and the general public (Álvarez, 2020).

Many scholars have conducted case studies of the use of geoparks in formal education. For instance, Henriques *et al.* (2012) published a study on education in Arouca Geopark in Portugal, concluding that using geoparks for educational intervention will encourage students to learn more about geoscience and stimulate their curiosity and interest in visiting other geoparks, and learning more about geoscientific issues. Similarly, Comănescu & Nedelea (2020) noted the need to intensify students' awareness and education regarding environmental factors at all levels and emphasized that geoeducation must be carried out both in and out of school.

Geopark activities have become widely popular in Japan (Watanabe, 2018). As of May 2023, Japan boasts 46 national geoparks, of which 10 are UNESCO Global Geoparks. The designation of national geoparks is determined by the Japanese Geoparks Network (JGN, 2023), which fosters collaboration among Japan's geoparks, including both established and aspiring geoparks. Educators have recognized the critical role of teaching programs in education in promoting geotourism, as highlighted by Ogata (2009). In line with this, Takahashi & Tsuchimoto (2016) suggested that teaching in geosites can effectively raise students' interest and develop a sense of local pride. Takenouchi (2016) also stressed the importance of geoparks in education, highlighting Itoigawa UNESCO Global Geopark's achievements in school education, where the local Municipal Board of Education has integrated the geopark into mandated education courses and has given teachers classroom training. Arima (2016) emphasized the value of geoparks in tourism education, which is why his study focused on Hakone Geopark and Teikyo University's tourism education project. Yuhora *et al.* (2016) found that the Muroto UNESCO Global Geopark facilitated connections between schools, governments, and local residents, enriching students' knowledge of geoscience, history, and culture. Geoparks facilitate formal education by establishing strong connections with schools, thereby enhancing geological knowledge at the basic education level and fostering environmental awareness in society (Catana & Brilha, 2020).

Schools in Shikaoi Town, northern Japan, had been designated as the 'Research Development Schools' by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) from April 2003 to March 2018. This resulted in the implementation of a 12-year consistent system of education for elementary, junior high, and high school students in the town (MEXT, 2022). In this program, an independent discipline known as the 'Geoeducation Program' was developed, encompassing a stage referred to as 'Shin-Chikyu Gaku' (New Earth Science). This has become a compulsory course for up to 15 years, aiming to foster the development of a sustainable society. Since its establishment, the Tokachi-Shikaoi Geopark, certified in December 2013, has been included in the educational program. However, discussions on education in the geopark are limited in scope and duration, resulting in the majority of related research focusing on the immediate effectiveness of such initiatives. In particular, our understanding of the long-term efficacy of education in the geopark is limited. Therefore, this study aims to (1) analyze what kind of education students had received as part of the subject of 'Shin-Chikyu Gaku' under the 'Geoeducation Program' in Shikaoi Town; (2) identify an improved and sustainable way in the Tokachi-Shikaoi Geopark; and (3) propose a new framework of education in Tokachi-Shikaoi Geopark, which can be applied to other geoparks.

Materials and Methods

Study area

Shikaoi is one of the towns in Hokkaido's Tokachi Subprefecture (Fig. 1A). The name 'Shikaoi' refers as 'following and hunting deer' and originates in the Ainu language as 'kutek-us-i' (Town of Shikaoi, 2016a). According to the 2022 census conducted by the Statistics Bureau of Japan, the town had a population of 5,266 and a total area of 404.7 km^2 as of January 2020 (Town of Shikaoi, 2016b).

The northern half of the Tokachi-Shikaoi Geopark is mainly composed of volcanic mountains belonging to Daisetsuzan National Park (Fig. 1B), whereas the southern half is on a flat plain with a large area of farmland. The Tokachi-Shikaoi Geopark covers the entire town of Shikaoi (Fig. 1C).

Numerous geological/geographical treasures have been conserved in the geopark, and will be passed on to future generations. In the distant past, mountain eruptions gave birth to various volcanic groups, transforming the land into a region rich in natural resources (Onishi, 2018). The Tokachi-Shikaoi Geopark is the only geopark in Japan with the theme of "ice" because of the existence of permafrost (Sawada *et al.*, 2003). People can experience the wisdom of life in a cold region, as well as the geography, ecosystems, and industries created by the cold and ice in the geopark. There are 17 heritage sites, which the geopark calles geosites. Visitors can explore and enjoy the geological, ecological, cultural and intangible local heritage at the 17 sites.

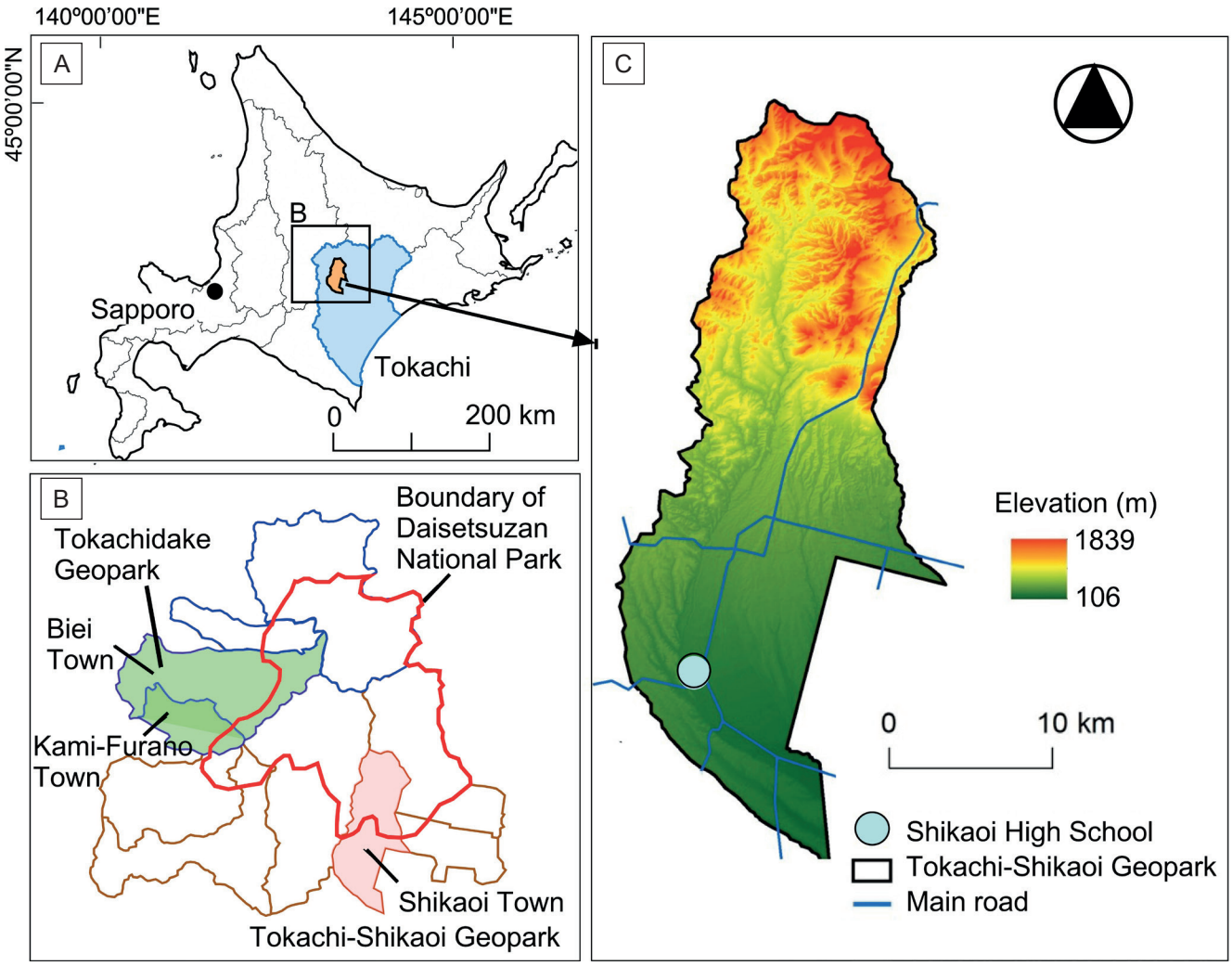

Fig. 1. Study area: A – location of Shikaoi Town in Hokkaido; B – Daisetsuzan National Park and its geoparks; C – Tokachi-Shikaoi Geopark, created with a 10-m Digital Elevation Model provided by the Geospatial Information Authority, Japan

Research materials

The Shikaoi Board of Education initially launched special programs of Canada Study (six-year English program from the 1st grade of elementary school to the 3rd grade of high school) and 'Shikaoi Gaku' ('gaku' means 'study' in Japanese), in April 2003, later referred to as the 'Geoeducation Program.' The initial program lasted for three years from April 2003 to March 2006 (Fig. 2). The same education program was adopted by MEXT in the 2nd term from April 2006 to March 2009. The Shikaoi Board of Education applied for the amended education program to MEXT and was adopted as the 3rd-term program under the title of the 'Chikyu Gaku' from April 2009 to March 2012. 'Shin-Chikyu Gaku' started in April 2012 and lasted until March 2018 as the 4th- and 5th-terms, which focused on environmental education, education for sustainable development and disaster prevention.

As mentioned before, schools in Shikaoi Town were selected as the 'Research Development Schools,' which had been designated for an exceptionally long period of five terms and 15 years in total. The 'Geoeducation Program' was a curriculum program developed by the Shikaoi Educational Research Institute and issued by the Shikaoi Board of Education. This program was designed to educate students on the importance of conserving local resources and fostering an understanding of the interdependence between human activities and the natural world. The curriculum encompasses four key domains: (1) regional nature/environment and disaster prevention, (2) regional culture, (3) international understanding, and (4) energy, with a focus on practical field studies and hands-on learning opportunities.

Textbooks of 'Shin-Chikyu Gaku' had been used from April 2012 to March 2018 (Fig. 2). This includes information about the Tokachi-Shikaoi Geopark. The 'Geoeducation Program' with the textbooks was implemented in all schools in the town: five elementary schools, two junior high schools, and one high school.

1st term	2nd term			3rd term			4th term			5th term			Post-program				Years students received Geoedu-cation Program
Canada Study & Shikaoi Gaku				Chikyu Gaku			Shin-Chikyu Gaku										
AY2003 -2005	AY2006	AY2007	AY2008	AY2009	AY2010	AY2011	AY2012	AY2013	AY2014	AY2015	AY2016	AY2017	AY2018	AY2019	AY2020	AY2021	
	EG1	EG2	EG3	EG4	EG5	EG6	JHG1	JHG2	JHG3	HG1	HG2	HG3					12
		EG1	EG2	EG3	EG4	EG5	EG6	JHG1	JHG2	JHG3	HG1	HG2	HG3				11
			EG1	EG2	EG3	EG4	EG5	EG6	JHG1	JHG2	JHG3	HG1	HG2	HG3			10
				EG1	EG2	EG3	EG4	EG5	EG6	JHG1	JHG2	JHG3	HG1	HG2	HG3		9
					EG1	EG2	EG3	EG4	EG5	EG6	JHG1	JHG2	JHG3	HG1	HG2	HG3	8
						EG1	EG2	EG3	EG4	EG5	EG6	JHG1	JHG2	JHG3	HG1	HG2	7
							EG1	EG2	EG3	EG4	EG5	EG6	JHG1	JHG2	JHG3	HG1	6
								EG1	EG2	EG3	EG4	EG5	EG6	JHG1	JHG2	JHG3	5
									EG1	EG2	EG3	EG4	EG5	EG6	JHG1	JHG2	4
										EG1	EG2	EG3	EG4	EG5	EG6	JHG1	3
										KG	EG1	EG2	EG3	EG4	EG5	EG6	2
											KG	EG1	EG2	EG3	EG4	EG5	1
												KG	EG1	EG2	EG3	EG4	0

Fig. 2. History of the development of the 'Geoeducation Program' in schools in Shikaoi Town in relation to the establishment of the Tokachi-Shikaoi Geopark. The core terms (3rd–5th terms) of the program (red) lasted for nine years, following the proto-type program in the 1st and 2nd terms. KG: kindergarten; EG: elementary school grade; JHG: junior high school grade; HG: high school grade. The yellow background indicates the students targeted for the questionnaire survey. AY: Academic years from April 1st to March 31st

The program, encompassing both 'Chikyu Gaku' (old version for the 3rd-term program) and 'Shin-Chikyu Gaku' (new version for the 4th- and 5th-term programs), also emphasized the importance of sustainable development and encouraged students to think critically about issues related to the environment. It aimed to foster responsible global citizens who could contribute to the conservation and protection of Earth's resources for future generations. It also focuses on the geoheritage of the area.

Methodology

This study obtained necessary data from an analysis of textbooks ('Shin-Chikyu Gaku'), questionnaire surveys, and interviews.

The 'Geoeducation Program,' unique to Shikaoi, affords a valuable opportunity to evaluate the effectiveness of its educational resources, including the pivotal 'Shin-Chikyu Gaku' textbooks. These textbooks play an essential role in the program's curriculum, and the aim is to assess their potential for further education within and beyond the geopark territory. This study adopted a content analysis approach that involves the interpretation of texts through the classification of content types (Hsieh & Shannon, 2005). For analysis, the contents of the textbooks were systematically categorized based on the information presented on each page. The methodology for the textbook content analysis is centered on evaluating the relationship between the knowledge content of the textbooks 'Shin-Chikyu Gaku' (Fig. 3) and the Tokachi-Shikaoi Geopark. This includes examining how the textbooks cover ecological, cultural, and historical aspects, as well as geoscience, to provide a holistic educational experience that fosters a sense of pride and connection among the local residents.

This study also examined data from online questionnaire surveys of students at Hokkaido Shikaoi High School between December 2020 and October 2021 (Tab. 1). The questionnaire was designed using the SurveyMonkey online survey service, a popular platform for creating and distributing customizable internet-based surveys. SurveyMonkey facilitates the creation of surveys with various question types and provides built-in tools for data analysis.

QR codes and URL links (https://www.surveymonkey.com), which were used to access the answer interface, were sent to all students with the cooperation of the school administrators. The questionnaire surveys achieved a high response rate (100.0%) and high effective rate (94.7%). The results of the surveys indicated an almost equal representation of male and female respondents, with 52.8% of the students being male and 47.2% being female.

The surveys included two types of questions. The first type of question aimed to evaluate students' understanding of knowledge about geoparks through a five-point Likert scale assessment, with points ranging from 1 to 5 (Jamieson, 2004).

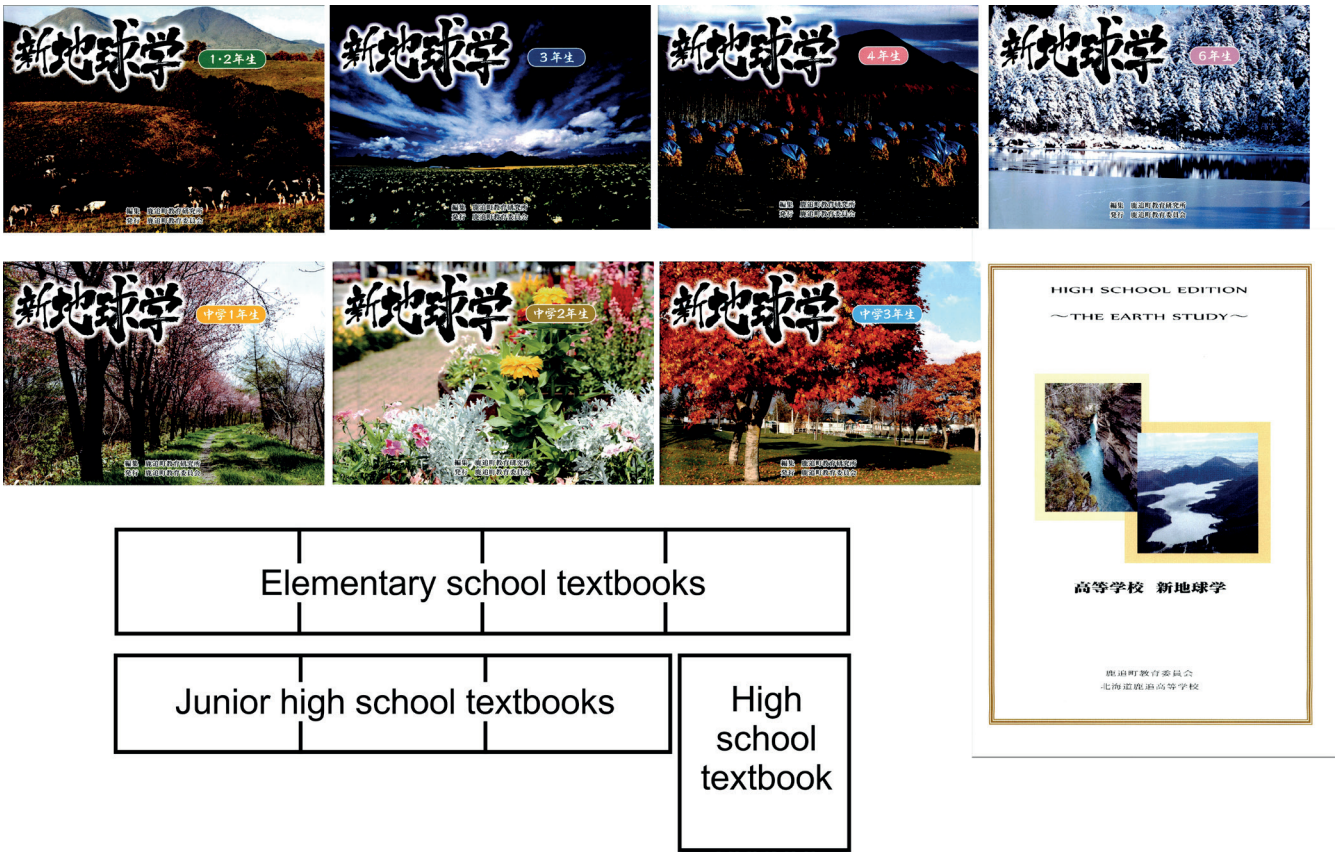

Fig. 3. The 'Shin-Chikyu Gaku' textbooks for elementary, junior high and high schools in Shikaoi

The higher score reflects a superior level of knowledge, as it is recorded in this manner. The second type of questions aimed to gather information regarding the students' attitudes towards life and to gauge any shift in their interests after having attended the 'Geoeducation Program.' The questionnaire surveys were administered to a total of 178 effective respondents, 112 of whom had six, seven, eight or nine years of learning experience and reported participating in the 3rd to 5th terms of the 'Geoeducation Program' (Fig. 2). Meanwhile, 66 students reported not having taken part in the program because they went to school in other towns or cities.

SPSS 24 for Windows was used to conduct both frequency and mean analyses. The results were compared to determine significant differences.

Finally, this study conducted qualitative in-depth face-to-face interviews with four key informants knowledgeable about education in the geopark (Tab. 2). The individuals selected as key informants were those responsible for different development stages of the 'Geoeducation Program', and their specialized knowledge was deemed essential to gain a deeper understanding of the issues and potential solutions related to the study.

Table 1. Details of the questionnaire surveys conducted with Hokkaido Shikaoi High School students

	Grade	Conducting date	Collection number	Collection rate [%]	Effective rate [%]
Questionnaire	Grades 1–3 in 2020	2nd Dec. 2020	188	100.0	94.7
	Grade 1 in 2021	12th Oct. 2021			

Table 2. Details of the interview surveys conducted with four key informants

Interviewees	Identity of the interviewees	Conducting date	Time duration
Mr A	Curator of the Geopark Visitor Center	November 12th and 14th, 2020	54 & 63 minutes
Mr B	Editor of textbooks "Shin-Chikyu Gaku"	November 13th, 2020	112 minutes
Mr C	Principal of Hokkaido Shikaoi High School	July 13th, 2021	109 minutes
Mr D	Director of the Shikaoi Town Board of Education	July 13th, 2021	53 minutes

Results

Textbook content analysis

For elementary school students, there were five books in total: one book was used by Grades 1 and 2, and it consisted of seven chapters across 24 pages. The other four books were designed for each grade level from Grades 3 to 6, with 22 pages each and containing nine, six, eight, and seven chapters, respectively. Geopark-related content varies: the third-grade textbook has four pages on geosites in the Tokachi-Shikaoi Geopark, the fourth-grade textbook has one page, the fifth-grade textbook allocates seven pages (five pages on the geopark and two pages on national parks), and the sixth-grade textbook dedicates 15.5 pages exclusively to the geopark.

Textbooks for junior high schools are composed of separate textbooks for each grade, with five chapters for the first and second years (26 pages and 28 pages, respectively), and six chapters for the third year (30 pages). Only the third-year textbook includes 2.5 pages on geoparks, with a detailed introduction to the Tokachi-Shikaoi Geopark.

The high school textbook, intended for students in the first to third grades, includes four chapters, each with three sections and a total of 89 pages. Here, five pages are devoted to geoparks, in which four pages are about concepts and origins, including a focus on the Tokachi-Shikaoi Geopark. Another page explores geoheritage.

All textbooks are A4 sized, tailored to suit students' learning needs, and cover themes including regional nature/environment and disaster prevention, regional culture, international understanding, and energy. Of the 285 pages in the elementary, junior high, and high school textbooks, 52.2% focused on regional nature/environment and disaster prevention, 17.3% on regional culture, 16.1% on energy, and 14.5% on international understanding (Fig. 4).

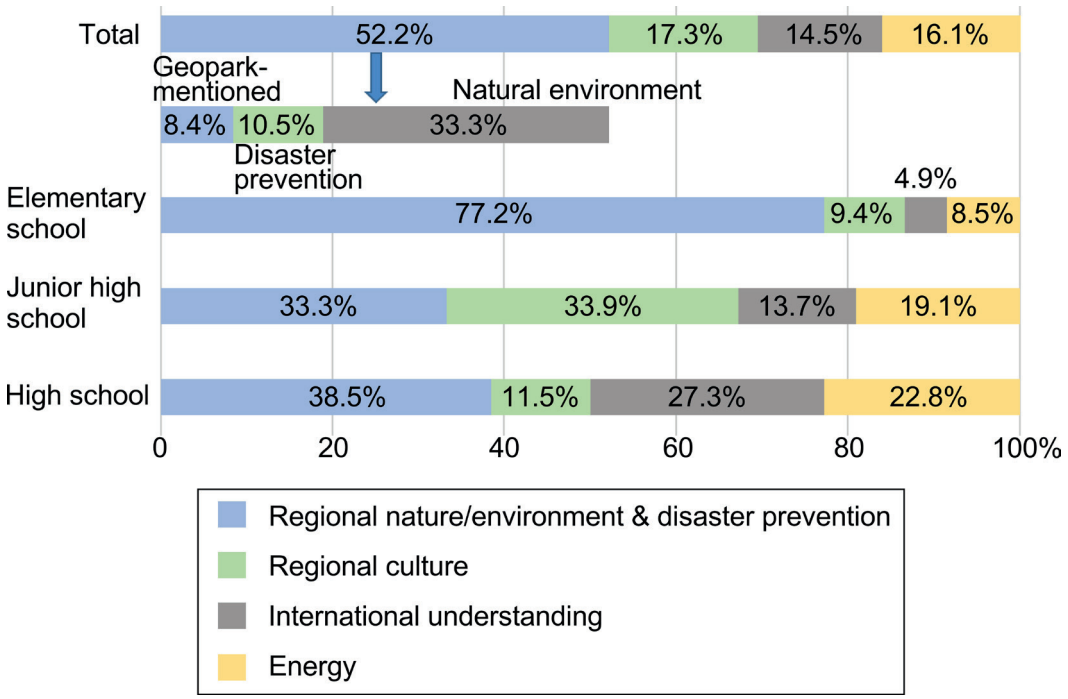

Fig. 4. The percentage of textbooks 'Shin-Chikyu Gaku' content for elementary, junior high, and high schools in Shikaoi Town

However, only small percentage (8.4%) of the regional nature/environment section and 10.5% of the disaster prevention section in the textbooks refer to the Tokachi-Shikaoi Geopark. This disparity points to a significant underrepresentation, considering the potential of the geopark as a contextual and educational resource.

Experiential learning in elementary schools, which includes direct engagement with the natural environment of Shikaoi Town, provides foundational appreciation for the local ecosystems. Elementary school textbooks also include disaster prevention instruction, which provides students with the knowledge they need to understand. As students advance to junior high and high schools, they encounter a broadened curriculum with the themes of regional culture and international understanding. However, the integration of geopark-related content remains shallow and does not leverage the full potential of the geopark as a tool for deepening environmental education and global awareness. For instance, the textbooks only provide a basic definition of geoparks and offer a brief introduction to the Tokachi-Shikaoi Geopark. While they mentioned some well-known heritage sites, these contents lack any direct connection to the Tokachi-Shikaoi Geopark. Such content fails to convey the ecological significance, geological diversity, and cultural heritage of the geopark, which are important to enhance students' understanding of the geopark's role in broader environmental and cultural contexts.

Therefore, while the progression of education in geopark from elementary to high school is satisfactory in scope and depth, there is an evident opportunity for more integrated and comprehensive inclusion of the Tokachi-Shikaoi Geopark throughout the curriculum. Enhancements could include the development of dedicated geopark chapters, interactive geopark-based activities, and fieldwork projects that align with each educational level's learning objectives, thereby ensuring strong, more meaningful engagement with geoheritage.

Assessing geo-knowledge comprehension among student groups

This study compared the knowledge and attitudes of two groups of students towards geoparks, specifically the Tokachi-Shikaoi Geopark. The first group consists of 112 students with experience in the 'Geoeducation Program,' while the second group consists of 66 students with no experience in the program. In the first group, 110 individuals were raised in the town of Shikaoi. The data indicated that students with program experience had a better understanding of geo-knowledge in textbooks, as shown in Fig. 5.

Figure 6A shows that 70.5% of students with experience in the program thought that geoparks should be established, compared to only 24.2% of students without experience. Furthermore, the results show that the students who had experience in the program had a greater interest in learning about geoparks (46.4% of them expressed this wish) than those who had no experience with the program (Fig. 6B). Students who had experience with the program had a considerably higher level of knowledge of the concept of geoparks than those who had no experience with the program (61.7% vs. 9.1%; Fig. 6C). Students who had experience with the program showed a higher level of pride (67.0%) in establishing the geopark in Shikaoi Town than those who had no experience (13.7%). Students who had no experience in the program showed a higher proportion of neutral attitudes (72.7%) towards the establishment of the Tokachi-Shikaoi Geopark (Fig. 6D).

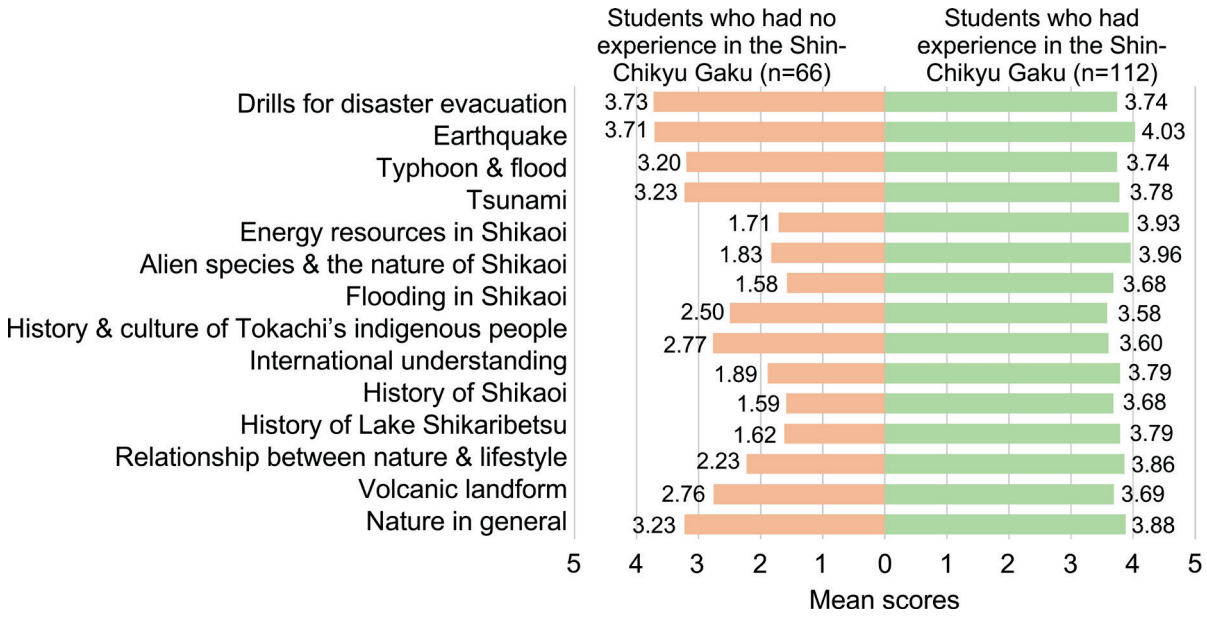

Fig. 5. Mean scores of students' understanding of the geo-knowledge of the 'Geoeducation Program, as measured by a Likert Scale in the two respondent groups

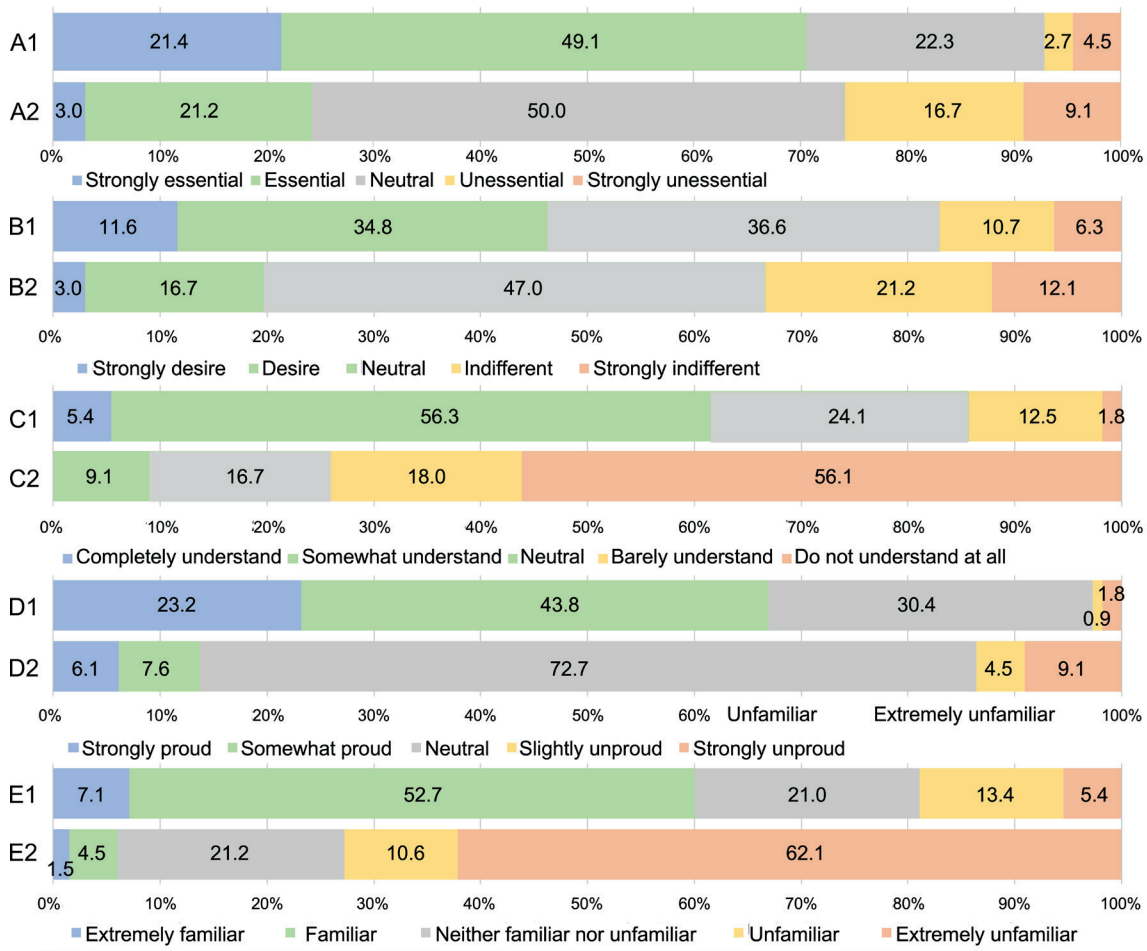

Fig 6. Assessing geo-knowledge comprehension between the two student groups

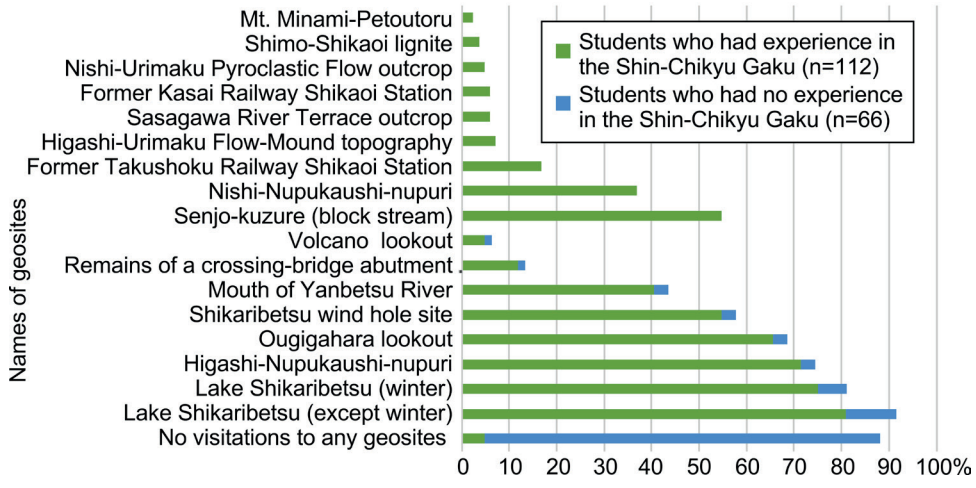

Fig. 7. Percentage of geosites visited by the two groups of students

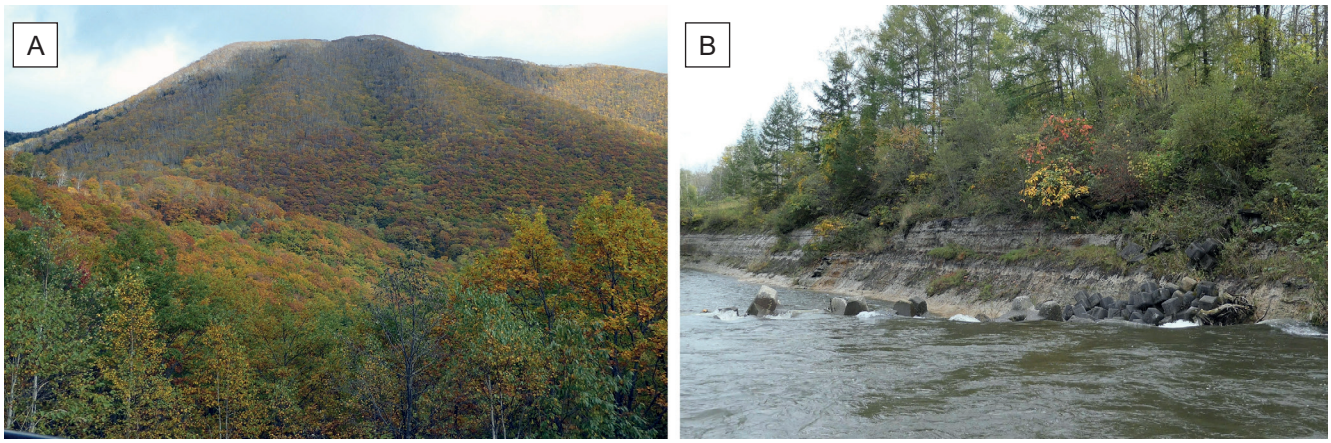

Fig. 8. Examples of geosites in the Tokachi-Shikaoi Geopark: A – Mt. Higashi-Nupukaushi-nupuri, one of the most popular geosites of the Tokachi-Shikaoi Geopark; B – Shimo-Shikaoi lignite outcrop, one of the least popular geosites, photos by T. Watanabe

The results also show that the students who had no experience in the program have limited knowledge about the Tokachi-Shikaoi Geopark, with 62.1% of them answering 'am extremely unfamiliar with the Tokachi-Shikaoi Geopark' (Fig. 6E). In contrast, students who had experience with the 'Geoeducation Program' had a higher level of knowledge about the geopark. There is an apparent association between participating in the program and visiting heritage sites in the Tokachi-Shikaoi Geopark, as shown in Fig. 7. In terms of school-organized visits to heritage sites during the program, students with experience in the program visited more heritage sites than those without. Except for a few well-known geosites (Fig. 8A), 83.3% of students with no experience in the program did not visit any heritage sites in Shikaoi (Fig. 7). It is important, however, to note that many students with program experience have not visited lesser-known heritage sites during their study of the program (Fig. 8B).

Assessing the impact of the 'Geoeducation Program' on students' attitudes and interests

Upon taking the 'Geoeducation Program' (n = 112), a considerable number of students underwent a change in their perspectives across various aspects of attitudes and interests about geoparks. As shown in Table 3, 17.0% exhibited heightened awareness of articles and news about geoparks, 13.4% felt equipped to inform tourists about the Tokachi-Shikaoi Geopark, and 4.5% were inspired to volunteer at geopark events. Beyond these geopark-centric changes, 50.0% of the students developed an increased concern for environmental conservation, and 16.1% gained interest in geology and geography. Despite these positive shifts, 28.6% reported no change in their attitudes, indicating potential areas for further program development.

Table 3. The number of the answers by the students who had experience with 'Geoeducation Program' being asked, 'Did you change your thoughts about any of the items below after learning of "Shin-Chikyu Gaku"?' (n = 112)

Statements	Number	Percentage
1. Started to pay attention to the articles and news about geoparks	19	17.0
2. Was able to confidently introduce the Tokachi-Shikaoi Geopark to tourists	15	13.4
3. Wanted to participate as a volunteer in the events that are held by the Tokachi-Shikaoi Geopark	5	4.5
4. Started to pay attention to environmental conservation	56	50.0
5. Became more interested in geology/geography	18	16.1
6. Others	1	0.9
7. Nothing had changed	32	28.6

Relevance of the 'Geoeducation Program' to the Tokachi-Shikaoi Geopark

As already mentioned, the primary goal of the 'Geoeducation Program' in Shikaoi was to encourage local sustainable development and provide students with a thorough understanding of the town's history, natural environment, and geoscience, thus fostering a local identity. Mr A from the geopark's visitor center stated that although the program was not initially designed with the Tokachi-Shikaoi Geopark in mind, it has been highly beneficial for students from elementary through high schools to receive education about the geopark and geoparks in general.

This program played a key role in assessing and re-evaluating the Tokachi-Shikaoi Geopark. All four key informants highlighted the importance of the 'Geoeducation Program' and expressed a strong attachment to it. They mentioned that some graduates of the program who were former students at Hokkaido Shikaoi High School later returned to Shikaoi Town and contributed to its socioeconomic and educational advancement. During the study tours to the heritage sites, the alumni shared their knowledge of the sites with their peers and instructors. They took pride in educating others about the geopark's unique geological/geographical features and historical significance, thereby contributing to a deeper understanding of the natural and cultural heritage of their hometowns. The key informants expressed concern that the termination of the 'Geoeducation Program' in 2018 would exacerbate the future shortage of talented individuals.

Discussion

The need of establishment of a new geoeducation program

The 'Geoeducation Program' was a component of the compulsory curriculum for all students in Shikaoi Town for 15 years in total. There are only two instances in which geoeducation has been positioned as a year-round subject in the Japanese school curriculum. One is Shikaoi, and the other is Itoigawa, central Japan (Takenouchi, 2016). Other geoparks that help education in Japanese schools offer lectures and study tours using lecture slots only.

Although the 'Geoeducation Program' in Shikaoi was completed in March 2018, its educational benefits have now been recognized. Students who had attended the program showed a higher understanding of knowledge of geoparks and more heritage site visitations (Figs. 5–7). One group of questionnaire survey respondents had taken the 'Geoeducation Program' for six years in elementary school or for seven to nine years in elementary and junior high schools (Fig. 3). In other words, no students had taken the Geoeducation Program at the high school level because the program was terminated before their enrollment (Fig. 2). Despite this, a clear difference in the educational efficacy was observed between the students who had studied 'Shin-Chikyu Gaku' for six to nine years in elementary school and junior high school and those who had not studied 'Shin-Chikyu Gaku' at all (Figs. 5–7). A survey of high school graduates who studied 'Shin-Chikyu Gaku' at the high school level was not conducted in this study because of the difficulty in accessing them.

Because the 'Geoeducation Program' in Shikaoi was terminated, introducing a similar program in the school curriculum is desirable. However, it would be extremely difficult to change the school curriculum in Japan in a decade or so: the responsible ministry (MEXT) has decided on a standardized curriculum based on the law to ensure that students can receive a certain level of education in all schools across Japan. Therefore, it is realistic to develop a new alternative educational program to be led by a geopark (or geoparks) with the cooperation of stakeholders.

Figure 9 illustrates the proposed framework led by the Tokachi-Shikaoi Geopark. Yuhora *et al*. (2016) pointed out that there are few professionals who can provide education related to geoparks in Japan. Partnerships among geopark experts, university researchers, and other stakeholders will compensate for the lack of geopark education specialists.

The involvement of the Tokachidake Geopark, another geopark in Daisetsuzan National Park (Fig. 1), is crucial to enrich the education program alongside the Tokachi-Shikaoi Geopark. This collaboration will be important to help provide study tours with heritage stories of geoparks. Every geopark is facing staff shortages. Cooperation between the two parks would be advantageous for both parks to develop better educational programs. Local outdoor guides can contribute to the study tour development and implementation as well. Such joint efforts can enhance the educational content and provide hands-on learning experiences that are critical for deepening students' understanding of geoscience.

Fieldwork is widely recognized as an effective learning strategy in geopark education (Orion, 1993; Loon, 2008; Stokes & Boyle, 2009; Esteves *et al*., 2015). Providing hands-on learning opportunities in a geopark can improve students' scientific literacy and contribute to positive social and economic outcomes. However, the education program shows weak connectivity between schools and many heritage sites within the geopark, as students rarely visit these sites (Fig. 7). By enhancing the collaboration between the experts of the Tokachi-Shikaoi and Tokachidake Geoparks, along with local outdoor guides, the best and strongest study tours will be offered at heritage sites in the geopark, potentially transforming educational outcomes and promoting greater local engagement.

Universities play a role in developing and updating textbooks with geopark staff members to ensure content accuracy and relevance. Specifically, the Tokachi-Shikaoi Geopark could benefit from a partnership with nearby universities due to their proximity and related academic research. Obihiro University of Agriculture and Veterinary Medicine and Hokkaido University, both located on the island of Hokkaido, would be potential universities to become partners although any other relevant universities may join in future. University faculty members and graduate students may help

to offer lectures to students. Universities also play a key role in teacher training programs.

Regarding schoolteachers' involvement, the results of the interview survey found that the burden on teachers was high: challenges faced by teachers in Shikaoi Town included increased stress levels and limited training opportunities during the 'Geoeducation Program.' Because the proposed educational framework will not be positioned as a school education program, the burden on teachers will be minimized. Nevertheless, educational support measures remain important (Takenouchi, 2016). Public schoolteachers change schools where they have worked for several years in Japan; therefore, support for new teachers transferred to and within the town is essential. The two interviewees highlighted the need for teachers to have a comprehensive understanding of geo-knowledge, which cannot be achieved solely through textbook learning. Interaction and experience with outsiders, such as geopark experts and university faculty members, will deepen schoolteachers' knowledge and interest in geoparks.

The textbook analysis revealed that students primarily sourced their geo-knowledge from the 'Shin-Chikyu Gaku' textbooks (Figs. 2, 4–6). Education textbooks play a crucial role in geopark education (Stern & Roseman, 2004) because they serve as a key guide for imparting essential knowledge to students at a specific age and for a specific discipline (Pingel, 2010). We concluded that the 'Shin-Chikyu Gaku' textbooks were successfully organized to make knowledge about geopark accessible to students.

Despite the benefits of textbooks, several challenges must be addressed to improve their efficacy for future use. One of the main challenges is the lack of sufficient information on the Tokachi-Shikaoi Geopark itself and geoparks in general (Fig. 4), which is natural because the Tokachi-Shikaoi Geopark did not exist when the textbooks were prepared. To address this issue, it is recommended that they be easily updated in the form of e-textbooks. As Waller (2013) points out, the development of e-textbooks is a cost-effective alternative. The development of e-textbooks provides not only students, but also teachers with accessible and comprehensive resources for understanding the natural world, cultural heritage, and local history.

In addition, expanding the coverage to include more heritage sites is advisable because in situ site teaching offers hands-on learning opportunities. These heritage sites, with their didactic potential, can be utilized through various routes to enhance students' understanding of the geopark's geoheritage (Arrad *et al*., 2020). Utilizing the existing geoheritage as a resource for educational programs and teaching materials, the Tokachi-Shikaoi Geopark can provide students with a deeper understanding of sustainable resource utilization and promote sustainable development and geotourism in the local community (Fig. 9).

Effective geoscience education can play a significant role in addressing the shortage of geospecialists and increasing the overall geoscientific literacy of society, as noted by Mayer (2002) and Gonzales & Keane (2010). Offering both outdoor (heritage site) and indoor learning (e-textbooks) can help cultivate geoscientific literacy and produce an adequate number of geospecialists to meet future workforce demands (Mosher *et al*., 2014). Two interviewees acknowledged the advantage of the 'Geoeducation Program' in imparting geo-knowledge to the students.

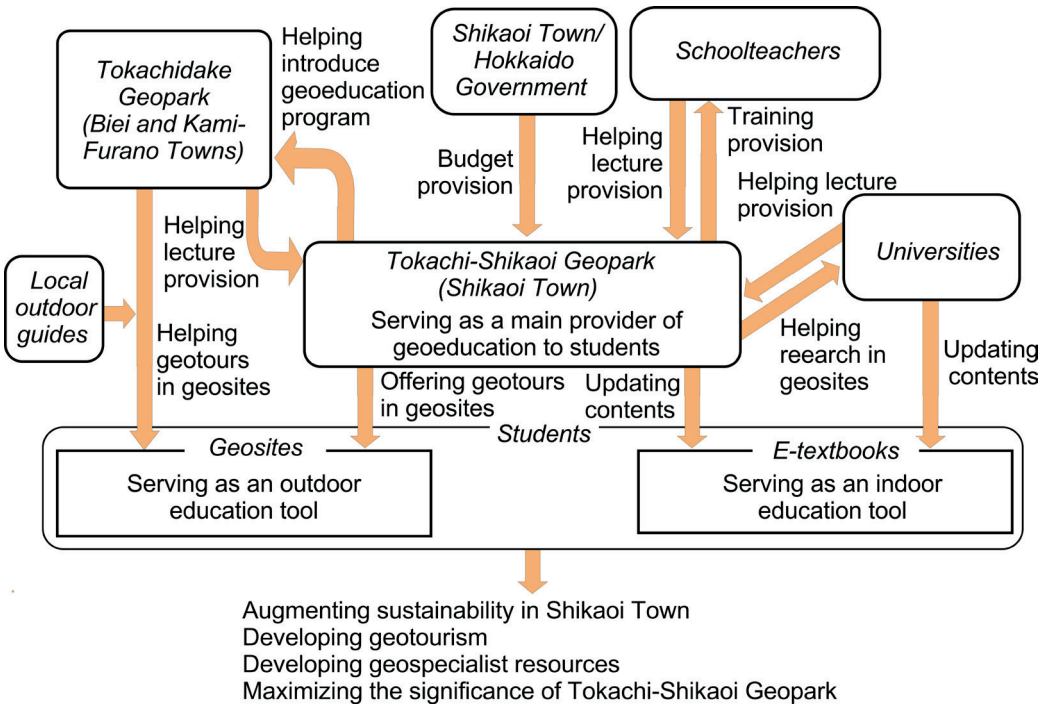

Fig. 9. Proposed geoeducation framework through a partnership program in Shikaaoi

Conclusions

This study presented the efficacy of the 'Geoeducation Program' in schools in Shikaoi Town, northern Japan, which lasted for 15 years from April 2003 to March 2018. The results of the questionnaire surveys revealed a substantial impact on students' understanding of and interest in geopark-related knowledge. The survey results found that not only indoor learning with textbooks but also outdoor learning at heritage sites is important. The results of the interview survey suggested the need for a training mechanism for schoolteachers, who can act as supporting instructors. However, there is room for introducing an alternative approach in the future. Utilizing geopark resources will be a realistic alternative provision of geopark education to students because revitalizing the school education system will be extremely difficult. Since most operating costs of the geopark are paid by the town, and since the available geopark staff members are limited, this study proposes to establish a new framework of partnership. This partnership was designed to offer outdoor (heritage site) and indoor (e-textbook) learning.

Continued budget acquisition will be the largest challenge for the proposed program, because there will be no initial budget to implement the new educational program under the proposed framework. Although this study did not discuss this issue, it is important to have cooperation between Tokachi-Shikaoi Geopark and Shikaoi Town to secure external funding support.

The declining population of Shikaoi Town underscores the significance of providing comprehensive education to future citizens. As highlighted by Ríos *et al.* (2020), geoeducation is instrumental in attaining Sustainable Development Goals (SDGs) by contributing to integral fulfillment. 'Geoeducation Program' plays a critical role in promoting sustainable development of Shikaoi Town through activities in the Tokachi-Shikaoi Geopark, as well as other geoparks. The approach ensures that the economic growth and development promoted by the geopark contribute to the broader sustainability of the region, focusing on long-term environmental management and avoiding the depletion of natural resources. By aligning educational actions with these objectives, the partnership framework between stakeholders and the geopark supports sustainable regional development to benefit both the local community and the natural environment.

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