STRENGTHENING COLLABORATION WITH THE ITOIGAWA UNESCO GLOBAL GEOPARK THROUGH STUDENT SDGS PROMOTERS AND VR EDUCATIONAL MATERIAL DEVELOPMENT

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Nagaoka University of Technology (NUT) established programs for the GIGAKU SDG Institute (UNESCO Chair) and GIGAKU SDG Network (UNITWIN Network) and has been promoting collaboration with UNESCO. The ongoing Science Working Group of the Youth Committee of the Japanese National Commission for UNESCO aims to strengthen collaboration with the Itoigawa UNESCO Global Geopark. In line with this initiative, students and faculty members from NUT, primarily from the student organization SDGs Promoters, including members of the Youth Committee of the Japanese National Commission for UNESCO, conducted research and hands-on activities in Itoigawa, Niigata Prefecture.
As part of the program, the group visited the Fossa Magna Museum, which offers an accessible and engaging exhibition on the formation of the Earth and the Japanese archipelago. They attended a lecture by a curator on the origins of the Fossa Magna, then explored the museum to learn about the region's rich geological history, including jade and the Itoigawa-Shizuoka Tectonic Line. In addition, they visited Benten Rock, a pyroclastic deposit from a submarine volcano about one million years ago. At Jade Beach, where a variety of stones can be found, they searched for jade stones that had washed down from the Kotakigawa Jade Gorge.
Following these activities, a survey was conducted among the student participants to explore effective ways to enhance collaboration with the Itoigawa UNESCO Global Geopark. The results indicated that many participants found the jade-searching experience particularly memorable, while others were impressed by the large-screen visualization of the formation of the Japanese archipelago.
Subsequently, students engaged in a group discussion to brainstorm strategies for attracting more visitors to the Itoigawa Geopark. Through this discussion, they proposed ideas such as a virtual jade-searching experience accessible from anywhere in the world and a visual representation of the formation of the Japanese archipelago and the Fossa Magna (a geological rift) as effective ways to promote the Geopark.
Based on these ideas, the group decided to develop multilingual VR educational materials to share the appeal of jade-searching and provide knowledge about the Fossa Magna to a wider audience. The VR content is planned to recreate the jade-searching experience and incorporate an interactive quiz feature related to the Geopark.

Keywords: *Engineering education, Geopark, SDGs, VR educational material*

Introduction

Nagaoka University of Technology (NUT) has been proactively promoting engineering education programs that incorporate the perspective of the Sustainable Development Goals (SDGs), adopted by the United Nations. In parallel, the university has also been engaged in various activities to raise awareness and deepen understanding of the SDGs in the local community.

To advance these efforts, NUT established the GIGAKU SDG Institute, which integrates SDG perspectives into its pioneering engineering education (GIGAKU: Science of Technology) programs. In 2018, the university became the first engineering institution in Japan to be designated as the UNESCO Chair programme, "UNESCO Chair on Engineering Education for Sustainable Development." Furthermore, in collaboration with nine institutions from six countries that share the same credos, NUT launched the GIGAKU SDG Network. In 2023, this initiative was officially recognized by UNESCO as the "UNITWIN Network for Engineering Education towards Sustainable Pathways," making it the third such network in Japan.

In 2020, NUT established the student organization "SDGs Promoters," which currently comprises 40 active members (10 Japanese and 30 international students as of

2025). Among them, two students who demonstrated outstanding commitment and achievements were recommended by NUT and, through the selection process of the Japanese National Commission for UNESCO, were appointed as members of its Youth Committee. Both students belong to the Science Working Group and, although there is no formal agreement between NUT and the Geopark administration, they have been actively contributing to UNESCO's mission through support activities for the Itoigawa UNESCO Global Geopark, based on mutual interests in youth engagement and UNESCO-related goals.

Itoigawa City, on the other hand, was the first location in Japan to be designated as a UNESCO Global Geopark in 2009. The city has utilized its rich geological assets, including the Itoigawa-Shizuoka Tectonic Line, which divides the Japanese archipelago, and jade, which is recognized as Japan's national stone, for regional revitalization. It is also known for its comprehensive educational approach that incorporates Geopark-based learning into local education for children from ages 0 to 18. However, due to the absence of a university or other higher education institutions in the city, engagement with young people aged 18 to 29 remains limited after they graduate from high school. While elementary, junior high, and high schools actively participate in Geopark-related learning through extracurricular activities and school programs, university-level involvement tends to rely on personal relationships, for example, with students studying geology or geomorphology in specialized laboratories elsewhere. This lack of structured collaboration with universities results in missed opportunities to involve non-local university students, who could otherwise bring fresh perspectives and interdisciplinary approaches. The project, therefore, focuses on reconnecting such youth with the Geopark through meaningful engagement opportunities.

To address this situation, the project aims to build a foundation for sustainable regional education that supports the protection and preservation of cultural and natural heritage from a scientific and engineering perspective, in alignment with SDG 11: Sustainable Cities and Communities. It also seeks to convey the value of the Geopark to young people and promote their participation in related activities. In addition, to expand learning opportunities beyond site visits, the project is developing VR educational materials designed to make the Geopark's appeal more accessible to a wider audience. This approach is expected to enhance the relevance and inclusivity of the content, particularly for diverse learners. The development of VR materials is considered essential not only for overcoming geographical constraints but also for offering flexible and engaging educational experiences tailored to the needs and preferences of the younger generation.

To implement specific initiatives such as the development of VR educational materials, this project was made possible with support from the National University Reform Enhancement Project.

Objectives

This project is structured around three primary objectives, each of which addresses a specific aspect of the overall aim to strengthen collaboration with the Itoigawa UNESCO Global Geopark and enhance sustainable regional education through student participation.

The first objective is to foster university students' development through practical inquiry-based learning. The primary target group is the SDGs Promoters at NUT, comprising both Japanese and international students. The goal is to cultivate their ability to identify and analyse regional issues from scientific and engineering perspectives. Through field visits, brainstorming sessions, and co-creation activities with Geopark experts and local stakeholders, students are encouraged to apply academic knowledge to real-world challenges and gain transferable problem-solving skills. This approach helps students become proactive contributors to sustainable development initiatives both locally and globally.

The second objective is to create opportunities for youth engagement in Geopark activities. Here, "youth" specifically refers to university students, particularly those from outside the Itoigawa region who would otherwise have no access to the Geopark through any formal educational program. While local children (ages 0 - 18) participate in structured learning through schools, this project fills a significant gap by involving university students in the planning and promotion of Geopark-based education. Students contribute not only as learners but also as facilitators, developing educational content and outreach strategies aimed at engaging peers. This is expected to strengthen long-term ties between young people and the Geopark, fostering sustainable community engagement.

The third objective focuses on the development and utilization of multilingual VR educational materials (VREM). This objective builds upon the student-led research and brainstorming activities. Students' diverse insights and ideas are incorporated into prototype content, which is iteratively refined. VR technology allows learners, particularly those who cannot physically access the Geopark, including international students and remote users, to explore its geological and cultural features in a highly engaging and realistic way. By providing content in multiple languages, starting with Japanese and English, the project promotes inclusive, global access. The final materials will be shared as open-access resources, expanding their educational value beyond the immediate project scope.

Materials and Methods

The first phase of this project was conducted from January 2024 to March 2025. During this period, a cumulative total of 40 student SDGs Promoters from Nagaoka University of Technology (NUT) participated in structured activities designed to support the objectives of the Science Working Group of the Youth Committee of the Japanese National Commission for UNESCO, with a specific focus on strengthening collaboration with the

Itoigawa UNESCO Global Geopark. A mixed-method approach was employed, combining field-based experiential learning, qualitative data collection through open-ended questionnaires, and participatory content design through brainstorming workshops. These methods encouraged learner autonomy and ensured relevance by engaging students in addressing real-world regional challenges.

The project commenced with a courtesy visit and information exchange meeting with Geopark officials. This was followed by an on-site field trip, where students attended a lecture by a curator at the Fossa Magna Museum and explored its exhibits. They also visited Benten Rock, formed by pyroclastic flows from a submarine volcano approximately one million years ago, and participated in hands-on jade searching at Jade Beach.

To capture initial impressions and inform future collaboration strategies, an open-ended online questionnaire (via Webform) was administered immediately after the field trip. Students were asked to reflect on their most memorable learning experiences and propose ideas for improving youth engagement with the Geopark.

Following this, two online brainstorming sessions were held using synchronous Zoom meetings and asynchronous discussions on Slack (Fig. 1). These sessions were designed to leverage diverse student perspectives and generate innovative outreach ideas. The decision to use brainstorming was guided by participatory co-creation methods commonly used in educational design. Proposals included gamifying the jade-searching experience, adapting the existing Geopark quiz provided by the Fossa Magna Museum, creating non-social-media-based digital outreach tools, and developing interactive content to visually explain the formation of the Japanese archipelago and the Fossa Magna.

Fig.1 Screenshot of the first online brainstorming session conducted via Zoom. Students from various disciplines shared ideas to promote the Itoigawa UNESCO Global Geopark, with a focus on accessibility, multilingual outreach, and interactive experiences.

During a second site visit to deepen understanding, students moved into the content development phase. They began designing and testing prototype elements of the VR materials, including gamified jade-searching experiences and quiz-based educational activities. Content development was conducted in multiple languages, reflecting the diverse cultural perspectives of the participating students. Given the project's limited budget and timeframe, development focused on creating a modular and scalable framework that could serve as the foundation for future expansion. The selection of activities, tools, and topics was informed by the students' reflections, input from Geopark experts, and alignment with SDG 11 goals.

Results

Between January 2024 and March 2025, a total of 40 students from the NUT SDGs Promoters participated in this project. The program was structured in four phases, which included on-site fieldwork, a questionnaire survey, online discussions, and the design of VREM. The students' experiences and proposals were documented, analysed, and reflected upon throughout the process.

In the questionnaire conducted after the field visit, the most memorable experiences cited by students included the jade-searching activity, the large-screen visualization of the formation of the Japanese archipelago, and on-site observation around Benten Rock, a geological formation created by a submarine volcanic eruption related to the Fossa Magna. On the other hand, when asked for suggestions to improve the Geopark and increase the number of museum visitors, students proposed a variety of creative ideas.

Many students suggested ways to further enhance the existing efforts by integrating experiential tourism and nature-based activities. In addition to current initiatives, they proposed ideas such as snorkelling and underwater observation around Benten Rock, developing tour packages that combine camping and hiking with visits to Geopark sites, and organizing seasonal nature programs for children during summer and winter.

To support and expand outreach to families and younger audiences, students proposed hands-on workshops such as fossil excavation and basic geology experiments, as well as kid-friendly exhibit spaces with simplified visual explanations. They also suggested incorporating gamified elements like stamp rallies or bingo to further enrich educational engagement.

Several responses emphasized the value of strengthening outreach and promotional strategies already in place. Suggestions included placing brochures and advertisements at major train stations in Niigata Prefecture, collaborating with railway companies to develop travel packages, and producing promotional content such as videos, posters, and blogs. Students also noted the potential benefit of diversifying communication platforms beyond social media and enhancing multilingual accessibility.

With regard to broader improvements to the Geopark, proposals focused on building upon existing strengths. These included developing model courses that incorporate surrounding areas such as Jade Beach, expanding souvenir and dining options, and improving infrastructure to offer more diverse visitor experiences.

Among the various ideas proposed, many students emphasized the importance of direct explanations from experts and curators, noting that such interactions not only deepen visitors' understanding but also add a sense of uniqueness to the experience. They highlighted that building opportunities for interaction with specialists would be crucial for enhancing the appeal of the Geopark.

Building on the questionnaire results, students participated in online brainstorming sessions and explored the future direction of VREM, inspired by NUT's ongoing work in metaverse applications. Ideas discussed included gamifying the jade-searching experience, utilizing existing quiz content provided by the museum, and creating visual content that explains geological phenomena such as the Fossa Magna and plate tectonics.

Figure 2 shows one of the collaborative brainstorming sessions, where students used a shared PowerPoint slide to visualize and organize ideas for the educational content. During the session, students emphasized the importance of incorporating game-like elements to maintain engagement, such as designing a "Quest" format in which users search for jade as items to progress through stages.

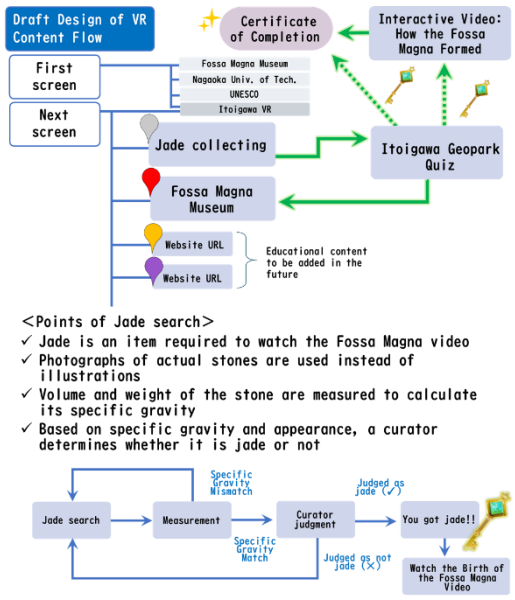

Fig. 2 Visualization of the second brainstorming session using a shared PowerPoint slide. Students categorized and refined their ideas into themes such as gamification, field experience, and cultural relevance, leading to the initial design of the VR educational materials. This figure is a reconstructed schematic based on students' original hand-drawn ideas.

They also expressed a strong preference for using real images of jade rather than illustrations to enhance authenticity and realism. These ideas were integrated into the planning of the VR materials.

As an initial step, the VREM was designed to include three main components. One is an explanation by curators, one is a jade-searching with educational elements activity, and the other is a Geopark quiz. These were developed as web-based educational resources accessible from anywhere in the world. The current framework was intentionally designed to allow for future scalability. To inform its design, an open-ended questionnaire was conducted to gather student reflections after the field visit, which contributed to shaping the subsequent development. Additional VREM content will be incorporated in stages, based on the characteristics and needs of each Geopark.

The current version of VREM includes multilingual audio guidance produced using text-to-speech technology based on written scripts, along with background music, to enhance user immersion through both visual and auditory channels. In the first stage, the jade-searching activity presents several stones on screen, from which users select the one they believe to be jade. They then conduct a simulated measurement of volume and weight to calculate its specific gravity. Based on the calculated value and the visual appearance of the stone, the curator avatar determines whether it can be identified as jade. Users who successfully identify jade can proceed to the next stage. The feeling of receiving a direct explanation from experts and curators is one of the key features.

In the following stage, users take part in the "Geopark Quiz Challenge," which consists of ten multiple-choice questions covering topics such as geology, landforms, and cultural features. Those who answer at least eight questions correctly are awarded a certification badge, providing a sense of accomplishment.

These ideas have been incorporated into the current design of VREM (Fig. 3). Through this project, students were given the opportunity to engage with regional issues from multiple perspectives and to translate their ideas, grounded in both academic knowledge and social relevance, into visible and practical proposals.

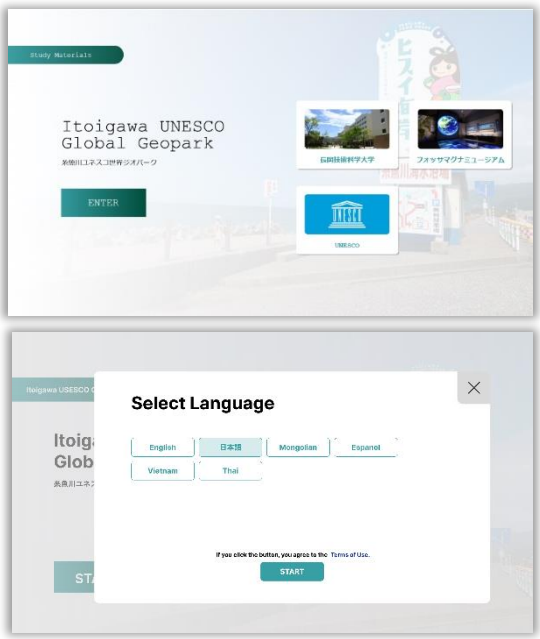

Fig. 3 shows screenshots of the VR Educational Material (VREM) prototype developed based on student input. The main features, jade-searching using visual characteristics and specific gravity, a curator avatar providing guided explanations, and a quiz challenge, were selected based on student proposals and implemented as core components of the prototype. These features reflect the ideas discussed and organized during the earlier brainstorming sessions.

Discussion

This project aimed to foster student growth, promote youth engagement in local activities, and develop VR educational materials that incorporate student ideas, accessible from anywhere in the world.

This comprehensive approach not only increased awareness of the Geopark but also suggested new pathways for reconnecting youth with regional heritage and sustainability issues.

Furthermore, the project emphasized the development of multilingual VREM. By leveraging the outcomes of fieldwork and collaborative learning, students created VREM that caters to diverse audiences, including non-Japanese speakers. Incorporating students' perspectives added authenticity and relevance to the materials, demonstrating the potential of student-led content creation to generate impactful and scalable educational resources. These resources may also be adapted for use by various institutions and regions.

The implementation of the metaverse elements posed financial challenges, which prevented the visual representation of the formation of the Japanese archipelago and the Fossa Magna. However, the current VREM framework is designed to accommodate future expansions. Once funding is secured, additional visual content will be incorporated to enhance the learning experience.

Conclusions

This project aimed to enhance collaboration with the Itoigawa UNESCO Global Geopark through field-based activities involving youth and to promote understanding of the Geopark's value from scientific and engineering perspectives. Through practical inquiry-based learning, students not only deepened their understanding of geological heritage but also proposed strategies to improve outreach and increase visitor engagement, such as gamified jade-searching activities, quiz-based learning modules, and multilingual visual explanations of geological phenomena. These strategies were developed through field observations, brainstorming sessions, and questionnaire feedback, and were partially implemented in the prototype of the VR educational materials.

The project led to concrete outcomes, including the development of ideas such as gamified jade-searching with educational elements, quiz-based learning, and visual explanations of the Fossa Magna and tectonic formation of the Japanese archipelago. These ideas were integrated into the design of multilingual VREM, and a prototype website featuring interactive content is currently under development.

This initiative suggests that, through their engineering perspective, university students can serve as effective mediators connecting the Geopark, scientific knowledge, and public audiences. Especially in regions where youth engagement opportunities are limited, such a role may prove to be significant. By combining hands-on experience with digital content creation, the project contributes to sustainable regional education and may serve as a model case for promoting youth participation. Further development, including expansion into languages other than Japanese and English, as well as more sophisticated content, is planned in collaboration with students and local stakeholders.

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