学 位 論 文 内 容 の 要 約

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学 位 論 文 題 名

Proposing a geoeducation framework for China's geoparks through insights derived from Tokachi-Shikaoi Geopark, Japan

（とかち鹿追ジオパークからの知見にもとづく中国のジオパークに対するジオ教育の枠組みの提案）

1. Introduction

Geoeducation plays a crucial role in geoparks, serving as a fundamental component for geoheritage conservation, environmental education, and sustainable regional development. Geoparks, as designated areas of geological significance, aim to protect geological relics, disseminate geoscientific knowledge, and foster local economic growth. Through geoeducation, these objectives are realized by promoting public awareness of earth science and conservation efforts. Despite its importance, research on geoeducation remains relatively underrepresented compared to studies on geotourism, geoheritage, and community development. A bibliometric analysis reveals that only 15.7% of studies from 2002 to 2018 focused on geoeducation, indicating a significant research gap. Moreover, the declining academic visibility of geoscience, coupled with diminishing undergraduate enrollments and university program closures, has posed further challenges to the development of geoeducation.

Some geoparks worldwide have a role of geoeducation and contributions to sustainable development. Notable examples include Portugal's Arouca Geopark, Spain's Villuercas-Ibores-Jara Geopark, and Japan's Itoigawa Geopark, all of which integrate educational programs into local curricula and community outreach. In China, the expansion of geoparks has been substantial, with 41 UNESCO Global Geoparks and 281 national geoparks as of 2020. Chinese geoparks actively incorporate

geoeducation into their management strategies, exemplified by the Huangshan UNESCO Global Geopark and the Dunhuang UNESCO Global Geopark, which provide structured educational programs for students and the public.

The chapter further explores the global geopark system, differentiating between UNESCO Global Geoparks (UGGps) and national geoparks. UNESCO formalized the concept of UGGps in 2015, recognizing them as regions of international geological significance managed through conservation, education, and sustainable development. The governance of these geoparks follows a bottom-up approach, such as community participation. In contrast, national geoparks, while serving similar purposes, operate under national frameworks and may adopt country-specific management practices. China has played a leading role in geopark development, boasting the highest number of UGGps and an extensive network of national geoparks. The Chinese Geopark Network (CGN), established in 2002, integrates state-led conservation and tourism initiatives. However, challenges persist, including administrative overlaps due to the coexistence of multiple protected area designations and varying management models that involve both state-owned and private enterprises.

Japan's geopark system follows a different trajectory, with geopark initiatives beginning in 2004 and culminating in the formation of the Japanese Geoparks Network (JGN) in 2009. Unlike China, Japan’s geoparks lack formal legal status and are managed through nonprofit organizations such as the JGN and the Japan Geopark Committee (JGC). These organizations oversee applications for UNESCO Global Geopark status and promote geoeducation through national and local initiatives. Japanese geoparks emphasize community-based education, disaster prevention awareness, and sustainable tourism, as demonstrated in the Muroto and Hakone Geoparks.

This study focuses on evaluating and enhancing geoeducation in China’s geoparks, drawing insights from Japan’s successful initiatives. Specifically, this study aims to: (1) propose a new geoeducation framework in Tokachi-Shikaoi Geopark, Japan, to maximize educational effectiveness; (2) assess the current geoeducational strategies

at Cuihuashan National Geopark, China; (3) identify areas for improvement and propose targeted recommendations; and (4) develop a comprehensive geoeducation framework for China's geoparks to ensure long-term sustainability.

The dissertation is structured to systematically investigate these objectives. The first result chapter provides an in-depth description of the Tokachi-Shikaoi and Cuihuashan Geoparks and the methodology employed for the study. The next chapter examines the current geoeducation model at Tokachi-Shikaoi Geopark and proposes an optimized framework. Then, geoeducation at Cuihuashan National Geopark is evaluated by highlighting its strengths and areas requiring improvement. Furthermore, findings from the previous chapters are integrated to offer recommendations for enhancing geoeducation in Cuihuashan and other Chinese geoparks. The final chapter concludes the study with summary of key contributions to the field of geoeducation. This study will contribute to the broader discourse on geopark management, conservation strategies, and sustainable education models. The findings are expected to inform policymakers, educators, and geopark administrators, facilitating the development of effective geoeducation programs that align with sustainable development goals.

2. Study area and methodology

This chapter introduces two study areas of Tokachi-Shikaoi Geopark in Japan and Cuihuashan National Geopark in China, where in-depth field surveys were conducted, and describes research methodology.

Tokachi-Shikaoi Geopark, located in Hokkaido, Japan, has integrated geoeducation into its local school system through the 12-year Geoeducation Program under Japan’s Ministry of Education, Culture, Sports, Science and Technology (MEXT). This geopark offers an ideal case for studying long-term geoeducation impacts.

Cuihuashan National Geopark, situated 25 km from Xi’an, China, is part of the Qinling Zhongnanshan UNESCO Global Geopark. The park was designated in 2011. It

is renowned for China's largest landslide relics, unique geological formations, and climate-influenced phenomena, including the Ice Cave and Wind Cave. This geopark plays a key role in geotourism, geoeducation, and conservation.

This study employs three key data collection methods: (1) questionnaire surveys to assess knowledge acquisition and attitude changes; (2) interview surveys with educators and geopark staff members to evaluate program effectiveness; and (3) content analysis of educational materials to determine their alignment with geoeducation objectives. Preliminary field research at Cuihuashan (January 2022) informed the study design, highlighting May–July as the optimal period for fieldwork.

By integrating qualitative and quantitative approaches, this research provides a comparative evaluation of geoeducation in Japan and China, offering insights to enhance educational frameworks and promote sustainable geoeducation strategies.

3. Analyses of the geoeducation program related to Tokachi-Shikaoi Geopark

This chapter examines the geoeducation program implemented in Shikaoi Town, Japan, in connection with the Tokachi-Shikaoi Geopark. The program, known as 'Shin-Chikyu Gaku', was integrated into the local school curriculum from 2003 to 2018, offering a 15-year structured geoeducation initiative across elementary, junior high, and high schools. The analysis focuses on the program's effectiveness, its long-term impact on students, and potential improvements for future geoeducation frameworks.

A comprehensive analysis of textbooks, teacher guides, and annual reports revealed the effectiveness and challenges of the program. The textbooks encompassed 285 pages across different school levels, with 52.2% focusing on regional nature, environment, and disaster prevention. However, geopark-specific content was underrepresented, with only 8.4% of nature-related sections explicitly referencing Tokachi-Shikaoi Geopark. Teacher guides supplemented the curriculum but lacked additional depth on geoparks. Annual reports indicated high engagement of students, with 87.9% of elementary and 77.2% of junior high students expressing interest in

‘Shin-Chikyu Gaku’ courses, though high school engagement declined significantly, reaching only 56.0% in 2014.

Questionnaire surveys conducted among 178 high school students revealed a significant gap in geoknowledge between students who had participated in the geoeducation program and those who had not. Among program participants, 70.5% believed that geoparks should be established, compared to only 24.2% of non-participants. Furthermore, 46.4% of program participants expressed interest in learning more about geoparks, while only 12.1% of non-participants did. The program participants also exhibited a higher level of pride in the Tokachi-Shikaoi Geopark (67.0%), whereas 72.7% of non-participants remained neutral about its significance. In terms ofgeoknowledge, 61.7% of the program participants demonstrated an understanding of geoparks, compared to only 9.1% of those who had not taken part in the program.

Interviews with key informants, including teachers, geopark administrators, and textbook developers, emphasized both the successes and limitations of the program. They noted that while the Geoeducation Program fostered local identity and environmental stewardship, its termination in 2018 due to policy changes and budget constraints created challenges for sustaining geoeducation in Shikaoi. The discontinuation of the program also raised concerns about a potential talent shortage in geoscience education and local conservation efforts. A lack of formal teacher-training in geoscience and the frequent relocation of teachers further hindered the continuity of the program.

Based on these findings, this chapter proposes a new geoeducation framework led by the Tokachi-Shikaoi Geopark, leveraging partnerships with universities, local outdoor guides, and other stakeholders. The framework emphasizes hands-on learning at geosites, e-textbooks for digital accessibility, and interdisciplinary collaborations to enhance geoeducation. The study underscores the need for sustainable funding support and external support to ensure the long-term success of geopark-based education.

By evaluating the Shikaoi Geoeducation Program, this chapter provides valuable insights for developing geoeducation models in other geoparks. The findings contribute to broader discussion on geoeducation's roles in fostering environmental awareness, sustainable development, and geoscience literacy.

4. Analyses of the geoeducation program related to Cuihuashan National Geopark

As mentioned earlier, Cuihuashan National Geopark is recognized for its well-preserved landslide geological relics, serving as a crucial site for geoeducation. This chapter analyzes the effectiveness of study tours in enhancing geoknowledge among students and evaluates their integration into the curriculum via the 'Xi'an Primary and Secondary School Research Travel Theme Route Guide.' The study examines how field-based learning at the geopark contributes to students' comprehension of geoscience concepts, attitudes toward environmental conservation, and engagement with geoheritage.

The content analysis of guidebooks revealed that each educational stage (elementary, junior high, and high school) includes a dedicated thematic route to the geopark, linking its features to relevant school curricula. However, the geopark-related content comprises only 2.4% of the total guidebook material, indicating a significant underutilization of its potential for geoeducation. Moreover, the junior high school guidebook lacks direct curriculum links, limiting its effectiveness in reinforcing textbook knowledge.

A questionnaire survey conducted among 248 high school students assessed their geoknowledge and attitudes before and after a study tour. Among students with prior study tour experience, the percentage who regarded geoparks as 'strongly essential' increased from 55.8% to 60.0%, while for first-time participants, the figure jumped from 3.3% to 52.3%. Also, familiarity with the Cuihuashan National Geopark improved significantly, rising from 18.3% to 49.7% in first-time participants. The percentage of students expressing pride in the geopark increased from 38.6% to 48.4%

among first-time participants, while it remained stable for those with previous experience.

Study tour participation was linked to increased environmental awareness, with 77.1% of first-time participants indicating greater concern for conservation, compared to 66.3% of those with prior study tour experience. Additionally, the desire to become a geopark volunteer rose from 33.7% to 50.5% among students with previous experience. A comparative analysis of geosite visitation showed that well-known sites such as the Geopark Museum had the highest visitation rate (93.7%), while lesser-known sites such as Cuihua Palace had low visitation rates (6.7% vs. 34.7%).

Interview surveys with six key informants, including geopark educators and schoolteachers, highlighted challenges such as a large group size of students (over 200 per tour), limited teacher involvement, and logistical constraints. Safety considerations and funding limitations restrict the frequency of the study tours, which currently occur only once per educational stage. Informants emphasized the need for improved teacher training, increased study tour frequency, and better integration of geoeducation into the curriculum.

To optimize the study tours, this study recommends (1) revising and updating guidebooks to enhance curriculum alignment, (2) increasing the frequency of geopark visits within school programs, (3) reducing the study group size and enhancing teacher participation, and (4) strengthening partnerships between the geopark and universities to improve educational content. These measures will enhance the impact of geoeducation and foster greater engagement with geoscience, conservation, and sustainable development among students.

5. General discussion

Geoeducation is a vital tool for promoting scientific literacy, environmental awareness, and appreciation of geoheritage. This chapter proposes a comprehensive geoeducation framework for Cuihuashan National Geopark, inspired by the Tokachi-Shikaoi model in Japan. The framework emphasizes three key strategies: fostering

collaborative partnerships, integrating outdoor and indoor learning, and addressing key challenges. Cuihuashan National Geopark can strengthen its role as an educational hub and enhance long-term sustainability by engaging government agencies, universities, schools, and local communities.

A dual approach combining hands-on field experiences at geosites with structured indoor learning through digital resources is recommended to maximize educational impact. The current study tour materials in Xi'an dedicate limited attention to Cuihuashan National Geopark, indicating an underutilization of its potential as an educational resource. To address this, digital learning materials such as e-guidebooks and interactive content are suggested as cost-effective and adaptable tools for expanding accessibility and engagement.

Despite the effectiveness of the study tours, challenges remain in ensuring frequency, depth of engagement, and long-term retention of geoknowledge. First-time participants show notable improvement in their understanding and appreciation of geoparks, but repeated exposure is necessary to deepen comprehension. Strengthening collaboration within the Qinling Zhongnanshan UNESCO Global Geopark network—such as joint initiatives with Zhuque National Forest Park—can help extend the reach of geoeducation. Additionally, financial barriers persist, as parents currently bear most of the study tour costs. To increase accessibility, the study recommends government subsidies, partnerships with local businesses, and resource reallocation to support geoeducation initiatives.

Expanding the framework to other China's geoparks is explored through two proposed models: the Complete Network Model and the Government-led Model. The Complete Network Model is suited for geoparks in educationally resource-rich regions, where multiple stakeholders collaborate effectively to provide financial, technical, and academic support. This study identifies ten national geoparks, such as Yunnan Chengjiang Fauna National Geopark and Beijing Shidu National Geopark, as prime candidates for adopting this model due to their proximity to universities and adjacent parks.

In contrast, the Government-led Model is designed for geoparks in remote or resource-limited areas that lack stakeholders' support. Many such geoparks, including Kanasi National Geopark and Zhada Shilin National Geopark, suffer from low visitor engagement and a weak digital presence. To bridge this gap, this study recommends developing digital platforms, including interactive e-learning resources and virtual geopark experiences, to expand accessibility. The potential for government-funded training programs to enhance educator capabilities and ensure scientific accuracy in geoeducation materials are also emphasized.

Both models align with Sustainable Development Goals (SDGs) by promoting quality education (SDG 4), sustainable communities (SDG 11), and climate action (SDG 13). Evidence from Danxiashan UNESCO Global Geopark highlights the effectiveness of integrating place-based learning with environmental stewardship, demonstrating how geopark-focused geoeducation contributes to both local and global sustainability efforts. By leveraging the proposed models, Cuihuashan National Geopark and other geoparks across China can enhance student engagement, strengthen environmental awareness, and foster a new generation of geoscientifically literate citizens committed to sustainability.

6. Conclusions

To enhance geoeducation in China's geoparks, this study draws insights from the geoeducation framework proposed for Tokachi-Shikaoi Geopark in Japan. Shikaoi's long-term integration of geoeducation into school curricula has fostered sustained student engagement, geoscientific literacy, and environmental stewardship. In contrast, Cuihuashan National Geopark in China, relying on one-day study tours, has demonstrated immediate but short-lived knowledge gains, particularly for first-time participants. Challenges such as limited teacher involvement, logistical constraints, and financial barriers restrict the program's long-term impact.

Based on these insights, two geoeducation models are proposed for China's geoparks. The Complete Network Model is designed for geoparks in educational

resource-rich regions, leveraging multi-stakeholder collaboration, digital learning, and integrated field experiences to optimize accessibility and impact. The Government-led Model targets remote and under-resourced geoparks, emphasizing government-supported digital platforms, virtual tours, and teacher training to bridge geographical and financial gaps.

These models align with Sustainable Development Goals (SDGs) by expanding access to geoeducation (SDG 4), fostering environmental awareness (SDG 13), and promoting local engagement (SDG 11). By leveraging the unique resources of geoparks, the proposed frameworks offer a structured approach to developing impactful and sustainable geoeducation programs. However, their effectiveness must be further validated through practical implementation and continuous evaluation to ensure long-term success and adaptability.