Integrating Scientific English and Life Science Learning to Foster Global Competence among High School Students

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Abstract

This study examines the educational effectiveness of an integrated science and English education program designed to foster global competence among high school students in a regional context. The program, implemented at Ehime University within the framework of the Japan Science and Technology Agency's Global Science Campus and the Next-Generation Science and Technology Challenge Program, combines scientific English instruction with life science learning and international engagement opportunities. Drawing on perspectives from Content and Language Integrated Learning (CLIL) and science communication education, the study explores how language-integrated science learning can support the development of intercultural competence and scientific communication skills. Participants included high school students who took part in the program between 2018 and 2024. Data was collected through rubric-based assessments and participant feedback. The evaluation focused on indicators such as intercultural understanding, logical expression, responsiveness in discussion, and communication ability in English. The results indicate that students who completed the program demonstrated measurable improvement in intercultural adaptability and increased confidence in communicating scientific ideas in English. Qualitative feedback also suggests that authentic experiences such as English-medium lectures, collaborative activities, and overseas research opportunities enhanced students' motivation toward global scientific engagement. These findings highlight the potential of regional universities to function as hubs for global science education and provide practical insights into the design of interdisciplinary programs that integrate language learning with authentic scientific practices.

[Keywords] Global science education, Scientific communication, Intercultural competence, CLIL (Content and Language Integrated Learning), Secondary science education

I. Introduction

In recent years, the internationalization of science education has become an important issue in both secondary and higher education (OECD, 2018; Knight, 2004). Scientific research increasingly develops through global collaboration, requiring scientists not only to possess advanced disciplinary knowledge but also to communicate effectively in English and engage with diverse cultural contexts. Consequently, the development of global competence and scientific communication skills has become a key objective in science education (National Research Council, 2012). Educational programs that integrate language learning with scientific research are therefore attracting increasing attention.

One educational approach that has gained attention in this context is Content and Language Integrated Learning (CLIL), which promotes the simultaneous development of subject knowledge and language proficiency (Coyle, Hood, & Marsh, 2010; Marsh, 2002). Within science education, CLIL-based approaches allow students to engage with scientific concepts while using English as a medium of communication. Previous studies have suggested that such integrated learning environments can enhance students' motivation, communication skills, and intercultural understanding, particularly when learners participate in authentic scientific practices such as discussion, presentation, and collaborative research (Lemke, 1990; Mortimer & Scott, 2003).

In response to these educational demands, Ehime University has implemented a series of programs aimed at fostering globally competent scientific talent among high school students in the region. These initiatives began with the Global Science Campus program supported by the Japan Science and Technology Agency (JST) and have continued through the Next-Generation Science and Technology Challenge Program. A distinctive feature of these programs is the integration of scientific English instruction with life science learning and international experiences. Through lectures, group work, and overseas research opportunities,

students are encouraged to develop both scientific understanding and intercultural communication skills (Kato *et al*., 2024).

The purpose of this study is to examine the structure and educational outcomes of this integrated science and English education program. This study investigates how language-integrated science learning and international experiences contribute to the development of intercultural competence and scientific communication skills among high school students. By analyzing the design and evaluation of the program, this research aims to provide insights into how regional universities can contribute to the internationalization of science education and the development of globally minded scientific talent (Fig. 1).

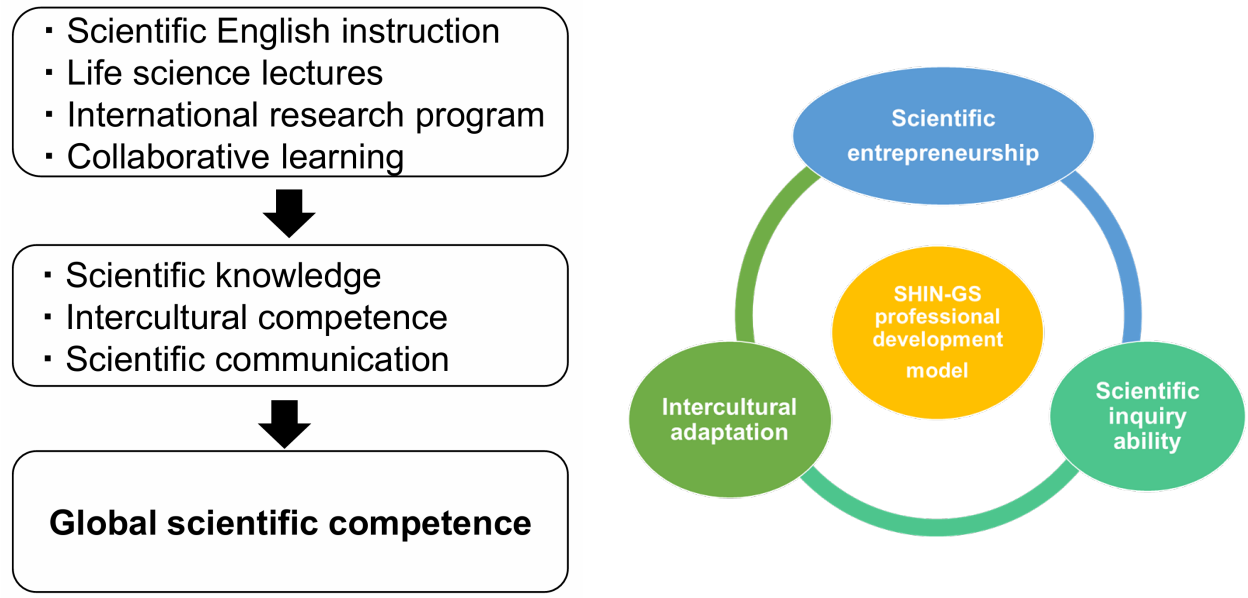

Fig. 1 Integrated educational model for fostering global scientific competence.
The program integrates scientific English instruction, life science learning, and international engagement opportunities to develop three core competencies: scientific knowledge, intercultural competence, and scientific communication skills.

II. Methods

1. Participants and Data Collection Period

This study targeted high school students who participated in Ehime University's integrated science and English education program between 2018 and 2024. The program was implemented as part of the Japan Science and Technology Agency (JST) Global Science Campus initiative and its successor program, the Next-Generation Science and Technology Challenge Program. Participants were selected through an application process designed to identify students with strong interest in science and international learning.

Data used in this study were collected during the second phase of the program (2023–present), which included structured scientific English instruction, specialized lectures in life sciences, and opportunities for international engagement. The participants consisted of high school students from the Shikoku region who took part in these educational activities.

2. Program Design

The program was designed to foster globally competent scientific talent by integrating scientific English education with life science learning and international experiences. The curriculum adopted a two-tiered instructional structure to accommodate differences in students' English proficiency and scientific background.

Tier 1: Foundational Scientific English

The first stage focused on developing foundational scientific English skills, including grammar, vocabulary, and reading comprehension related to scientific topics. Online instructional materials were used to provide accessible learning opportunities regardless of students' geographic location. Through these activities, students became familiar with scientific terminology and basic forms of communication in English (Fig. 2).

- **Foundational Language Skills**

Focuses on basic grammar, vocabulary, and reading skills to build a solid scientific English foundation.

- **Accessible Online Instruction**

Classes use online platforms to allow students to access learning materials from any location.

- **International Student Interaction**

Interaction with international peers helps students acquire practical language skills naturally.

- **Flexible Educational Model**

Tier 1 offers a flexible approach suitable for a wide range of students as a first step in science English.

Fig. 2 Example of online scientific English class (Tier 1)

Tier 2: Specialized Scientific English and Life Science Learning

The second stage introduced more advanced scientific learning through English-medium lectures and collaborative activities (Fig. 3). A lecture on parasitology was conducted entirely in English and included group discussions, microscope-based observation activities, and question-and-answer sessions. These activities were designed to encourage students to engage with scientific content while simultaneously practicing communication in English.

In addition to classroom-based activities, the program provided opportunities for international engagement, such as participation in overseas research programs and interaction with international researchers. These experiences aimed to create authentic contexts for scientific communication and intercultural learning (Fig. 4).

- **Developing Advanced Language Skills**

Focus on advanced scientific vocabulary, logical sentence structuring, and academic presentation techniques.

- **Practical Communication Training**

Includes English discussions, research presentations, and peer-reviewed paper composition practice.

- **Preparing for Global Scientific Community**

Equips students with skills to present at international conferences and write English scientific papers confidently.

Fig. 3 Flyer of the English-medium parasitology lecture used in Tier 2

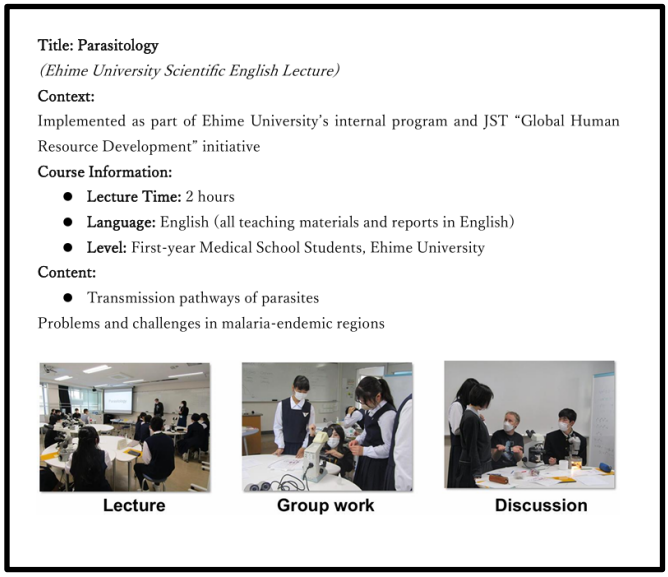

Fig. 4 Structure and schedule of the parasitology class

3. Evaluation Method

To evaluate the educational outcomes of the program, rubric-based assessments were conducted focusing on the development of intercultural competence and scientific communication skills. The evaluation criteria included intercultural understanding, logical coherence in scientific explanation, clarity of expression, responsiveness during discussions, and communication ability in English.

Participants' performance was assessed based on their participation in discussions, presentations, and collaborative activities conducted during the program. In addition, qualitative feedback from participants was collected to understand their perceptions of the program and its impact on their motivation toward international scientific engagement.

III. Results

The results indicate that participation in the integrated science and English education program contributed to improvements in students' intercultural competence and scientific communication skills. Rubric-based evaluations showed that students who completed the program demonstrated higher scores in several categories, including intercultural understanding, logical explanation, clarity of expression, and responsiveness during discussions.

In particular, the rubric assessment indicated that students who completed the program showed approximately 1.2 times higher levels of intercultural adaptability (from rubric score 2.1 to 2.5) compared with their initial evaluations (Fig. 5).

Qualitative feedback also suggested positive educational outcomes. Several students reported increased confidence in communicating scientific ideas in English. Some participants noted that participation in English-medium lectures and discussions contributed to improvements in their English listening abilities, including preparation for the EIKEN examination.

Furthermore, participation in international activities appeared to enhance students' motivation toward global learning opportunities. In 2024, eight high school students participated in an overseas research program at Indiana University, where they attended lectures and presented their research findings in English (Table 1). Students submitted written reports after the parasitology lecture. The reports were evaluated using a rubric assessing scientific understanding and English expression.

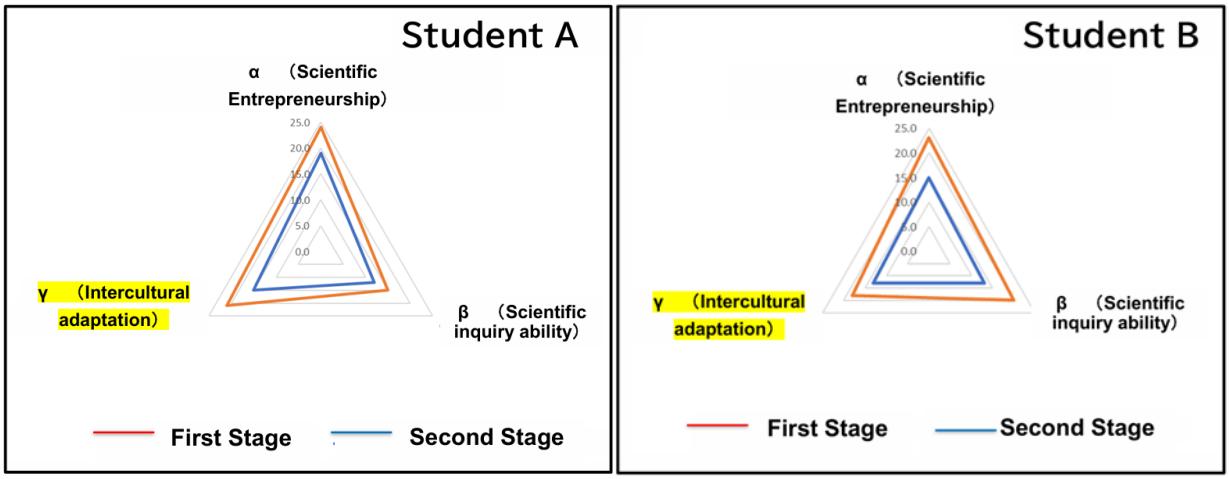

Fig. 5 Changes in students' intercultural adaptability based on rubric evaluation

Table 1 Evaluation results of parasitology report assignments

Q1. What is a parasite?

- Parasites is a creature that lives in other animals. They do host animal's harm. However, their selves can gain some benefits. Many parasites are discovered around the world.
- A parasite is an organism that lives on or in a host organism and gets its food at the expense of its host. Ectoparasites drink blood or feed on skin from the host's body surface. Endoparasites are active in the host's body.
- A creature that lives on the body surface or inside the body as a host for other creatures and uses the host to survive.
- An animal that lives as a parasite on another animal for a period or for life, absorbing nutrients from that animal.

Q2. Can you name some parasites of humans?

- Fleas, Flea eggs, Flea larvae, Flea pupae, Ticks, Mosquitoes, Sand flies, Mites, Lice
- There are about 200 types of human parasites in the world and about 100 in Japan.
- Caterpillars, tapeworms, fleas, lice, mites, Japanese lacertine striped worms, Japanese blood sucking worms and Manson's blood sucking worms
- For example, Anisakis, Mosquito, Malaria.

Q3. Can parasites control the behaviour of their hosts?

- Yes, they can. Some parasites can control the behaviour of their host.
- Yes, they can. Cordyceps and hedgehogs, etc
- Yes, they can. Parasites that parasitism snails can move the snails to conspicuous areas where they can be seen by birds. Parasites that parasitism mantises also make the mantis move towards the water to get out of the mantis.
- Depends on the type. For example, hedge beetles. They parasitize mantis. So they can control them. The mantis that was controlled jump into rivers and lakes. Because hedge beetles return rivers and lakes to breed.

Q4. Are parasites important?

- Yes, parasites are important. It's because parasites play an important role in ecosystem. For example, they can control increasing dominant species. Then parasites make biological diversity grow.
- Yes, they are. In some cases, the host and the parasite have a cooperative relationship of interest.
- Yes. Not unimportant, as host-parasite symbiosis can occur.
- Yes, they're. They can pest control. If they don't exist, environment will change a lot.

Q5. Should we eliminate all parasites from the world?

- No, we shouldn't eliminate all parasites. It's because they give benefits to people and biological diversity. So, I think that we should symbiosis with a variety of parasites.
- No, we shouldn't. Some parasites are life-threatening, such as malaria, while others help other creatures live comfortably.
- We should not. Parasites harmful to human that we have not discovered may have some role to play in nature. Therefore, we think it is necessary to take measures such as creating vaccines to prevent infections and other diseases that are not harmful to humans.
- No, we should not. They have a role to pest control. In addition, they are useful for people. For example, they contributing to medical care. Furthermore, they have become one of the endangered animals. We should protect them!

Assessment Item	Average Score
Scientific understanding	82
Logical explanation	84
English expression	81
Overall score	83

IV. Discussion

The findings of this study suggest that integrating scientific English instruction with disciplinary science learning can contribute to the development of global competence among high school students. The improvement observed in rubric-based evaluations indicates that students developed greater confidence in communicating scientific ideas in English and interacting in international learning environments. These results are consistent with previous studies emphasizing the importance of intercultural competence as a key outcome of internationalized education (Deardorff, 2006).

From the perspective of science education, the program demonstrates how language-integrated science learning can support students' participation in authentic scientific practices. Science learning is not limited to the acquisition of conceptual knowledge but also involves participation in scientific discourse and communication practices within scientific communities (Lemke, 1990; Mortimer & Scott, 2003). In the present program, students engaged in English-medium lectures, group discussions, and presentations, which provided opportunities to experience forms of communication like those used in international scientific contexts.

The results also support previous discussions on interdisciplinary STEM education that emphasize the integration of scientific knowledge with communication skills and global perspectives (Bybee, 2013). By combining scientific English instruction with life science learning and international experiences, the program created a learning environment that connected disciplinary knowledge with global scientific communication.

Another important implication concerns the role of regional universities in promoting global science education. International education initiatives are often concentrated in large metropolitan universities; however, this study suggests that regional universities can also function as effective hubs for global science education. Through collaboration with international researchers and overseas institutions, regional universities can provide students with opportunities to engage in global scientific learning environments.

Nevertheless, several limitations should be noted. The present study focused on participants in a specific educational program, and the sample size was relatively limited. Future research should examine the long-term impact of such programs on students' academic development and career trajectories in science. In addition, further studies could explore how language-integrated science education models can be adapted to different educational contexts and disciplines

V. Conclusion

This study examined the educational impact of an integrated science and English education program implemented at a regional university. The findings suggest that combining scientific English instruction, life science learning, and international experiences can effectively support the development of intercultural competence and scientific communication skills among high school students. The results highlight the potential role of regional universities as important hubs for global science education. Future research should further explore the long-term impact of such programs and refine educational models that connect local science education with global scientific communities.

Acknowledgments

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References

Bybee, R. W. (2013). *The case for STEM education: Challenges and opportunities*. Arlington, VA: NSTA Press.

Coyle, D., Hood, P., & Marsh, D. (2010). *CLIL: Content and language integrated learning*. Cambridge: Cambridge University

Press.

Deardorff, D. K. (2006). Identification and assessment of intercultural competence as a student outcome of internationalization. *Journal of Studies in International Education*, 10(3), 241–266.

Kato, A., Schneider, P., O'Donnell, A. J., & Culleton, R. (2024). International collaboration to inspire future scientists: Hands-on parasitology activities in the classroom. *Bulletin of the Center for Research in Science Education, Ehime University*, 3, 23–30.

Knight, J. (2004). Internationalization remodeled: Definition, approaches, and rationales. *Journal of Studies in International Education*, 8(1), 5–31.

Lemke, J. L. (1990). *Talking science: Language, learning, and values*. Norwood, NJ: Ablex Publishing.

Marsh, D. (2002). *CLIL/EMILE: The European dimension—Actions, trends and foresight potential*. Brussels: European Commission.

Mortimer, E. F., & Scott, P. (2003). *Meaning making in secondary science classrooms*. Maidenhead: Open University Press.

National Research Council. (2012). *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press.

OECD. (2018). *The future of education and skills: Education 2030*. Paris: OECD Publishing