

CRITICAL THINKING IN CARTOGRAPHIC EDUCATION AND LEARNING WITH GENERATIVE AI: A PROMPT- ENGINEERING FRAMEWORK FOR IDENTIFYING AI HALLUCINATIONS IN THE EAST SEA NAMING DISPUTE

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Abstract

This study explores a project-based geography teaching method that combines generative AI and digital maps, focusing on the East Sea naming issue. It addresses the lack of classroom studies on digital cartography, multilingual prompting, and AI literacy in geography education. The proposed six-stage framework includes Guidelines, Iterative, Summarising, Inferring, Transforming, and Expanding. Students compare online maps, international materials, digital content, and AI responses to examine marine toponym conflicts, paying attention to linguistic variation and hallucination issues like translation errors and fabricated facts. Surveys show increased interest in geography, better understanding, and improved AI analysis skills, with reduced unconditional trust in AI info. The findings suggest the design enhances conceptual understanding, engagement, digital literacy, and critical inquiry, positioning generative AI as a pedagogical tool for critical thinking and collaboration in geography.

Keywords: Generative AI; digital maps; marine toponym conflict; East Sea naming issue; geography education; global citizenship education; digital media literacy

INTRODUCTION

Geopolitical conflicts involve international diplomacy and represent significant educational challenges that influence students' understanding of space, identity, representation, and global coexistence. In geography education, disputes concerning naming, boundaries, and territorial interpretation demand more than rote memorisation. Effective pedagogical approaches should empower students to interrogate competing claims, critically analyse cartographic representations, and reflect on the construction of knowledge across languages, media, and political contexts. The East Sea naming issue serves as a pertinent example that integrates marine toponymy, international representation, digital cartography, and global citizenship.

The rise of generative AI, especially large language models like ChatGPT, has gained attention in education. These tools offer personalized learning, improve analytical skills, and facilitate interactive simulations, fostering collaboration (Kasneci et al., 2023). Generative AI is seen as a pioneering resource providing customized feedback and assessing students' comprehension, critical thinking, and literacy. This sets it apart from previous digital tools, leading to increased recognition in education (Walton Family Foundation, 2023; U.S. Department of Education, 2023). Its integration has sparked discussions on its utility (Adeshola & Adepoju, 2023), effectiveness (Molick & Molick, 2023a), classroom use (Molick & Molick, 2023b), and relation to artificial cognition (Siemens et al., 2022). Geographic education scholars stress the importance of acknowledging AI's significance and taking practical steps (Chang & Kidman, 2023; Kim, 2022; Yoo, 2023; Lee, 2024). This highlights the need for active academic engagement.

The widespread adoption of generative AI is transforming classroom practices, serving as both an instructional tool and a subject for critical analysis. In geography and cartography education, generative AI supports the collection, reorganisation, comparison, and reformulation of information from diverse sources. It also enables multilingual inquiry and critical engagement with digital representations. However, its educational application presents challenges. AI-generated responses may vary across languages, reflecting biases in training data. It produces a variety of digital content

results that appear authoritative but may be inaccurate. These characteristics highlight the necessity of critical evaluation when teaching controversial geographical issues, particularly with respect to sources, perspectives, and representational practices.

Previous research has examined the educational value of addressing geopolitical issues and incorporating AI-assisted learning. However, there is a lack of concrete classroom designs that integrate digital maps, multilingual prompting, and critical analysis of AI-generated outputs into project-based geography instruction. This study addresses this gap by designing and analysing an instructional model focused on the East Sea naming issue. It explores how generative AI and digital maps can be combined to facilitate students' critical inquiry into marine toponym conflicts and examines the educational implications for global citizenship, digital media literacy, and geography learning.

METHOD

Rationale for Topic Selection

The East Sea naming issue was chosen as the central theme of the instructional project due to its strong connection to students' lived experiences and its potential to enhance relevance and motivation in learning. This issue is readily linked to textbooks, news reporting, digital media, and online maps, enabling students to connect classroom inquiry with materials encountered in daily life. It is educationally significant as it encourages examination of marine place names, international naming practices, and the politics of representation in maritime contexts. Additionally, analysing the historical background of marine toponymic conflicts, international response patterns, and potential avenues for peaceful engagement may foster the development of global citizenship.

Data Sources and Instructional Materials

The lesson design incorporated diverse materials, including textbooks, news articles, map-based resources, publications from international organisations, digital platform content, and AI-generated responses in multiple languages (see Table 1). These materials were used comparatively, enabling students to examine both factual content and differences in representation, framing, and emphasis across sources. Objective information, such as geographic location, naming conventions, historical usage, and international naming principles, formed the foundation for inquiry. Generative AI was then employed to organise, compare, and reformulate information, with its outputs cross-verified against non-AI materials.

Instructional Design Principles

Three core principles guided the instructional design. First, inquiry into marine toponym conflicts should begin with objective, verifiable materials rather than unexamined opinions. Second, generative AI should serve not only as an answer-providing tool but also as an object for cross-verification and critical analysis. Third, the instructional process should promote the simultaneous development of higher-order thinking, digital media literacy, and digital citizenship. Accordingly, the lesson was structured as project-based geography instruction, engaging students in investigation through comparison, interpretation, reflection, and collaborative discussion.

Six-Stage Prompt Framework

To facilitate structured inquiry, this study implemented a six-stage prompt framework adapted from prompt engineering methodologies associated with generative AI: Guidelines, Iterative, Summarising, Inferring, Transforming, and Expanding. This framework organised students' engagement with the East Sea naming issue in sequential stages, guiding them from initial orientation and fact-finding to synthesis, interpretation, comparison, and broader application to similar cases. The staged design aimed to minimise confusion, promote progressively deeper inquiry, and enhance students' ability to independently reconstruct geographical meaning.

INSTRUCTIONAL DESIGN AND FINDINGS

Geographic Content in the Six-Stage Prompt Framework

The Guidelines stage introduced lesson objectives and defined the conceptual boundaries of the issue. The Iterative stage prompted students to compare claims, evidence, and map-based representations across multiple sources. The Summarising stage required synthesis of the conflict's background and analysis of naming and response patterns among international organisations, nation-states, and digital mapping platforms. The Inferring stage tasked students with formulating evidence-based inferences about potential future developments. The Transforming stage encouraged reinterpretation of the issue from various perspectives, including those of Korea, Japan, and third parties. The Expanding stage connected the East Sea naming issue to similar marine toponym disputes globally. Collectively, these stages

demonstrate that generative AI can be an effective tool for fostering critical inquiry in project-based geography instruction.

Linguistic Relativity and Hallucination in Generative AI

A key component of the lesson involved comparing AI-generated responses to identical prompts submitted in Korean, English, Japanese, Chinese, and French. This activity revealed significant differences in content and perspective across languages. For instance, prompts entered in Japanese often produced responses more closely aligned with the Japanese position in both logic and phrasing. These variations indicate that AI-generated content is shaped by language-specific distributions of training data, cultural context, and expression conventions. These findings underscore the importance of language choice when students use generative AI to investigate contested geographical issues.

The lesson also enabled students to identify hallucination-related issues in AI-generated responses. For instance, the Chinese translation of “the East Sea” was incorrectly associated with “East China Sea,” resulting in entirely different geographical information. More broadly, the study categorised erroneous responses into six types: translation error, fabricated fact, contextual distortion, fictitious combination, logical leap, and overgeneralization (See Table 2). These patterns highlight the necessity of treating generative AI as a resource requiring critical scrutiny, particularly in geography education, where place names and cartographic representations significantly influence spatial understanding and identity (See Table 3).

Educational Effects Identified through Pre- and Post-Surveys

The educational effects of instructional design were assessed using pre- and post-surveys. Overall, post-survey means exceeded pre-survey means across most items, indicating positive changes in students’ interest in geography, understanding of geographical concepts, and AI-related analytical competencies. Notably, students’ interest in geography increased substantially, and items related to core geographical understanding, such as marine spatial concepts, also improved. These results suggest that the instructional design contributed to both student engagement and conceptual learning (See Table 4).

Conversely, items assessing unconditional trust in AI-generated information showed lower post-survey scores. This trend indicates that students became more discerning in evaluating the reliability and accuracy of AI outputs after the lesson. In this respect, the instructional design supported not only geography learning but also the development of digital media literacy and critical inquiry (See Table 4). Paired-samples t-tests revealed statistically significant differences across several items, particularly those related to understanding geographical concepts and critically analysing AI-generated information (See Table 5).

DISCUSSION

The findings of this study indicate that project-based geography instruction incorporating generative AI and digital maps is pedagogically effective when focused on critical inquiry rather than simple information retrieval. In the context of marine toponymic conflict, students were required not only to identify correct answers but also to compare competing claims, analyse cartographic and linguistic representations, and assess the reliability of digital outputs. These results suggest that generative AI can be repositioned in geography education as a pedagogical resource for interpretive comparison and collaborative inquiry.

This study also has implications for cartography education. The East Sea naming issue represents not only a geopolitical dispute but also a matter of representation, encompassing how marine spaces are named, displayed, translated, and legitimised across maps and digital platforms. By engaging students in comparing naming practices across online maps, international materials, and multilingual AI outputs, the lesson highlighted the politics of cartographic representation and the constructed nature of map knowledge. From this perspective, generative AI may serve as an effective entry point for integration. More broadly, the study suggests that critical engagement with hallucination, bias, and language variation should be incorporated into geography instruction as a substantive learning objective, rather than being treated as a technical issue external to the curriculum. When students encounter errors, distortions, or inconsistencies in AI-generated responses, they may become more attentive to the processes by which geographical knowledge is produced, disseminated, and validated. This approach may foster learning outcomes relevant to both geography education and global citizenship education in digitally mediated environments.

CONCLUSION

This study examined project-based geography instruction that integrated generative AI and digital maps, using the East Sea naming issue as a case study. The lesson was organised through a six-stage prompt framework and encouraged students to engage critically with marine toponym conflicts by comparing multilingual AI responses, online maps, and institutional materials. The findings indicate that such instruction may enhance students' interest in geography, conceptual understanding, and AI-related analytical skills, while also fostering more critical attitudes toward AI-generated information.

This study is significant because it reconceptualises generative AI as a pedagogical resource for critical inquiry and collaborative problem solving in geography education, rather than solely as an information-delivery tool. It further suggests that marine toponymic conflicts provide a meaningful context for integrating geography, cartography, digital media literacy, and global citizenship education.

Several limitations should be acknowledged. The study involved a relatively small number of classes, which constrains the generalisability of the findings. Additionally, as generative AI technologies evolve rapidly, the instructional design presented here will require ongoing revision to remain current with technological developments. Future research may benefit from applying this instructional model in more diverse educational contexts, examining long-term effects, and exploring the applicability of similar approaches to other geographical controversies and related areas of cartography education.

Table 1. Lesson Plan Overview for the Project “Practical Measures for Peace and Coexistence amid Geopolitical Conflict”

Category	Content
Unit	World Citizenship and Geography
Section	IV-3. Geopolitical Conflict and Efforts for Peace
Lesson Session	Session 4
Project Title	Practical Measures for Peace and Coexistence amid Geopolitical Conflict
Achievement Standard	[12-WCG-04-03]
Learning Objectives	<ol style="list-style-type: none"> 1. Students will be able to understand the geopolitical causes of the naming disputes surrounding the East Sea and explain how perceptions of these place names differ across countries. 2. Students will be able to propose policy measures for addressing the naming conflicts surrounding the East Sea in constructive ways through the use of generative AI.

Note. This table presents the core structure of the lesson plan translated from the original Korean instructional outline. The lesson was designed for a project-based geography unit addressing the East Sea naming disputes.

Table 1 (continued) Lesson Procedures

Lesson Stage (Time)	Instructional Activities
Introduction (20 min)	Attendance and lesson preparation: Confirm attendance and students' seating; check students' laptop setup; organise groups and distribute individual worksheets. Activating prior awareness of the East Sea issue: Use Mentimeter to ask students to enter words freely associated with the East Sea.
Development (30 min)	Recognising the naming dispute through Google Maps: Examine how the names used for the East Sea vary across countries because of country-specific algorithms and big-data environments. Viewing news reports on geopolitical disputes related to the East Sea: Explain cases of naming disputes involving the East Sea in the context of Korea-US-Japan diplomatic relations; explain the significance of place names in relation to patriotism and awareness of national sovereignty as core competencies in geography education; explain the importance of critical thinking in relation to geopolitical conflict.
Development (140 min)	Analysing international place-name disputes through generative AI using Google Sheets: Instruct students to analyse the naming dispute using prompt-engineering techniques in the order of Guidelines → Iterative → Summarising → Inferring → Transforming → Expanding; provide circulating guidance and feedback to each group. Mid-project presentation: Invite selected students to share responses and questions; explain that in socially contested issues involving values, such as international territorial conflict in East Asia, big data and algorithms may vary by country and language depending on the language used. Continue circulating guidance, feedback, and scaffolding and then conclude the activity.
Closing (10 min)	Sharing and presenting project outcomes: Students compare AI-generated responses across languages within their groups, discuss possible ways to address international conflict, and discuss which AI-generated responses they judged to be erroneous and on what grounds. Group representatives briefly present their activity outcomes. Conduct peer assessment based on the presentations. Wrap-up and preview of the next lesson: Organise equipment, collect activity sheets, introduce the next lesson, and conclude the class.

Note. Lesson-stage terminology and activity descriptions have been standardised for manuscript consistency. Time allocations reflect the original Korean table.

Table 2. Categorised Student Responses to the Item “Provide Evidence of Hallucination”

Category	Student Response
Recognition of language- and country-based differences in perspective	I realised that generative AI may not always be accurate after seeing that the answers differed depending on the national perspective from which the question was asked.
Recognition of language- and country-based differences in perspective	After using ChatGPT during today’s lesson, I noticed that what appeared on an actual map differed from ChatGPT’s answer, which made me realise that it does not provide only accurate information.
Recognition of language- and country-based differences in perspective	Although Dokdo is internationally recognised as a disputed area, it is clearly our territory on the basis of objective evidence. Through this activity, I realised that AI may provide information aligned with the perspective of a powerful country such as Japan.
Recognition of language- and country-based differences in perspective	I tend to accept it because it often provides information that appears reasonably trustworthy, but there are times when it presents misconceptions or repeats contradictory statements, so I feel that additional investigation is necessary.
Recognition of language- and country-based differences in perspective	In the case of generative AI developed by non-Korean companies, it seems unable to grasp the deeper contextual nuances of Korean adequately.
Recognition of language- and country-based differences in perspective	The conversation moved in an entirely inappropriate direction because the East Sea was interpreted as the East China Sea or the South China Sea.
Factual error	If one asks a question after assuming something false to be true, it frequently fabricates plausible-sounding information in response.
Factual error	The period at which geopolitical conflict over the naming of the East Sea began appeared differently depending on the language used, including 1910, 1945, and 1990.
Omission of information	Even though there is clear historical and geographical evidence showing why the name of the East Sea should not be “Sea of Japan”, the system responded that it could not find such evidence.
Lack of informational consistency	Even when I asked the same question, the answer changed from moment to moment, which made me think that generative AI provides different answers depending on the big-data information it searches at that time.

Category	Student Response
Lack of informational consistency	Every time I asked the same question repeatedly, the answer changed slightly, which made it confusing to determine what was actually correct.
Lack of informational consistency	At one point it said that “Sea of Japan” was the official expression, and later it said that the expression “East Sea” had been used more frequently in recent years.
Information bias related to political sensitivity	Although it sometimes provides correct information, when asked about topics involving political elements, it appears either to evade the question ambiguously or to provide answers that differ from reality.
Information bias related to political sensitivity	It certainly provides objective information in many cases, but when an issue inevitably contains subjective elements, AI still provides different information depending on the country involved, which lowers its reliability.

Note. Categories were standardised for consistency across the manuscript. Student responses were translated as faithfully as possible while smoothing syntax for publication-ready presentation.

Table 3. Student Reflections on the Reliability of Generative AI

Student Reflection
While using ChatGPT, I came to think that ChatGPT is simply a programme that strings words together, and I realised that it was not designed to produce accurate knowledge.
I think that when it does not fully understand a question, it may provide an incorrect answer.
Since big data is ultimately information created by humans, it can never be completely objective. Inaccurate information is also continuously collected in real time, and if the volume of such information becomes large enough, erroneous information may end up being treated as if it were valid.
I confirmed that even information concerning data or numerical values is presented differently across languages when the topic involves some element of dispute.
Generative AI relies on internet-based information, yet the internet contains not only accurate information but also fake news and false information. Therefore, generative AI may also provide false information.
In response to complex and sensitive questions such as those related to territory and territorial waters, I found that AI responses changed from moment to moment.
It appeared to depend on the questioner more than expected, which led me to realise how difficult objective information analysis can be.
It was unsettling to see it confidently describe events that never actually occurred as though they had happened. When the error was pointed out immediately, it revised the content and admitted the mistake, which made it seem less trustworthy.

Student Reflection

If one presses generative AI, it may produce answers in the way one wants. In other words, AI may be steered by the subjective views of the questioner. If many people spread incorrect information, AI will also provide incorrect answers. In the end, perhaps this is a kind of information struggle in the information age.

Note. This table reproduces students' written reflections on the reliability of generative AI. Wording has been translated into academic English while preserving the meaning of the original Korean responses.

Table 4. Changes in Mean Scores for Pre-test and Post-test Survey Items

Dimension	Item	Pre-test Mean	Post-test Mean
Student Interest	1. I think geography is an interesting subject that I would like to learn.	3.692	4.354
Geographical Concepts	2. I can clearly explain the concept of territory.	3.154	4.077
Geographical Concepts	3. I can clearly explain the concept of territorial waters.	3.031	4.138
Geographical Concepts	4. I can accurately identify the geographical and hydrographic location of Dokdo.	3.231	4.046
Geographical Concepts	5. I can accurately identify the geographical location of the East Sea.	3.154	4.185
Awareness of Geographical Issues	6. I can explain what kinds of territorial disputes Korea is engaged in with other countries.	3.615	4.369
Awareness of Geographical Issues	7. I can explain the disputes related to the naming of Korea's territory and territorial waters.	3.400	4.338
Awareness of Geographical Issues	8. I know at least three examples of territorial/territorial water disputes around the world.	2.846	3.892

Dimension	Item	Pre-test Mean	Post-test Mean
Awareness of Geographical Issues	9. I can explain the geopolitical reasons why countries around the world continue territorial/territorial water disputes.	2.846	4.092
Use of Generative AI	10. I can explain different types of generative AI, such as image, text, and video.	3.215	4.262
Use of Generative AI	11. I can appropriately collect the information I want by using generative AI.	3.754	4.354
Use of Generative AI	12. I understand and can formulate the concept of a “prompt” (question) in order to use generative AI.	3.369	4.277
Use of Generative AI	13. I tend to trust most of the big-data information presented by AI.	3.231	2.677
Use of Generative AI	14. I can critically and logically analyse the information I obtain through the use of AI.	3.523	4.077
Use of Generative AI	15. I think generative AI provides only accurate information.	3.615	2.400

Note. Pre-test and post-test means are reproduced from the original Korean statistical table. Item wording was standardised to align with the terminology used in the manuscript body.

Table 5. Paired-Samples t-Test Results for Pre-test and Post-test Survey Items

Item	t	p
1. I think geography is an interesting subject that I would like to learn.	-6.541	0.000
2. I can clearly explain the concept of territory.	-7.407	0.000
3. I can clearly explain the concept of territorial waters.	-8.077	0.000

Item	<i>t</i>	<i>p</i>
4. I can accurately identify the geographical and hydrographic location of Dokdo.	-5.815	0.000
5. I can accurately identify the geographical location of the East Sea.	-7.531	0.000
6. I can explain what kinds of territorial disputes Korea is engaged in with other countries.	-5.809	0.000
7. I can explain the disputes related to the naming of Korea's territory and territorial waters.	-6.389	0.000
8. I know at least three examples of territorial/territorial water disputes around the world.	-6.928	0.000
9. I can explain the geopolitical reasons why countries around the world continue territorial/territorial water disputes.	-10.371	0.000
10. I can explain different types of generative AI, such as image, text, and video.	-7.598	0.000
11. I can appropriately collect the information I want by using generative AI.	-5.861	0.000
12. I understand and can formulate the concept of a "prompt" (question) in order to use generative AI.	-7.469	0.000
13. I tend to trust most of the big-data information presented by AI.	3.182	0.002
14. I can critically and logically analyse the information I obtain through the use of AI.	-4.395	0.000
15. I think generative AI provides only accurate information.	8.605	0.000

Note. Values are presented as reported in the original Korean t-test table. Statistical symbols are formatted in a journal-consistent style, with italicised *t* and *p* used in the title and note conventions of the manuscript.

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BIOGRAPHY



Kim, Young-Hoon (김영훈) holds a Bachelor of Arts in Geography from Kyungpook National University (1991), a Master of Science in Geographic Information Science from the University of Edinburgh, United Kingdom (1996), and a Doctor of Philosophy in Geography from the University of Leeds, United Kingdom (2001). Professor Kim has been affiliated with Korea National University of Education, Korea, since 2004. His research interests encompass geospatial analysis and modelling, cartography, and their educational applications at the school level, particularly through the integration of digitalised teaching and learning models with convergent educational perspectives, such as augmented reality (AR), artificial intelligence (AI), and geospatial themes. He currently serves or has served as president of various academic organizations, including the Society for the East Sea (2025–present), the Korean Cartographic Association (2026–present), and the Korea Regional Geography Association (2023–2024).

Kim, So-Yeon (김소연) is presently employed as a high school geography instructor in Korea. Following the completion of her master's degree at Korea National University of Education, she enrolled in the doctoral program in Geography Education at Seoul National University to pursue research. Her fields of expertise include geography education utilizing geographic information, geography education integrated with generative AI, and digital cartography.