Semantic network analysis on the geography of food as represented in textbooks: for alternative food education for young people

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Abstract: This study compared the structural characteristics of the geography and pedagogy of food for young people, which is represented in geography textbooks used by the IBDP and Korean world geography. By using the KrKwic, which is a semantic network analysis software, the study analyzed the extent to which factors related to the geography and pedagogy of food for young people were reflected in two geography textbooks as well as the semantic network and degree centrality by which these factors formed each other. The results suggest that future world geography textbooks need to consider alternative competencies for young people, such as global citizenship, food citizenship, and environmental sustainability, when dealing with the geography of food.

Subjects: Secondary Education; Human Geography; Cultural Geography; Economic Geography

Keywords: geography textbook; geography of food; content analysis; semantic network analysis

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PUBLIC INTEREST STATEMENT

We can explore the relationship between human and nature through the topic of food. Because food includes nature, agriculture, culture and resources and so on. Food is not only an important factor in everyday life, but also an important position in school education. Development of geography education using recent food geography components is a continuous and demanding process. Before developing such content, there is a need to examine and analyze the food-related elements in the current school geography textbooks. Content analysis of geography textbooks can be the basis for improving geography education using food geography. In this study, we revealed the structural characteristics that reflect food geography-related factors in an International Baccalaureate Diploma Program (IBDP) geography textbook and a Korean world geography textbook through a semantic network analysis, and present some implications for geography education.
1. Introduction

Geography is a subject that explores the relationship between humans and nature, and we can explore the relationship between humans and nature through the topic of food since food includes nature (e.g., land and climate), agriculture, culture and resources, and so on. Food is one of the three essential factors in everyday human life, is an essential condition of human life, and, simultaneously, is closely related to the environment surrounding us as well as our personal health.

Moreover, food is not only an important factor in everyday life but also holds an important position in school education (Mowell, 2003). In particular, in home and nutrition education, the focus rests on teaching skills, attitudes, and values in a classroom of students with an interest in acquiring knowledge concerning effective nutrition and cooking methods. Food is also taught as an important part of science education (especially biology and chemistry) and in geography education but with a different emphasis (Morgan, 2012; Rao Subba et al., 2012). Geography is interested in space and place, so when it comes to food, it asks questions such as “Where does your breakfast come from?” (Coe et al., 2007). In addition, people are also interested in the journey of food, for example, in the journey from coffee cherries to a cup of coffee. The globalization of food has started being discussed recently, and it can even be said that “our tables contain the whole world.” As Bell and Valentine (1997) said, “we are where we eat”; further, as others have said, “we are what we eat.” Such notions inform us that food is everywhere in our lives—that is how important it is. Eating is as important as breathing and drinking clean water; however, we take many things for granted and do not pay enough attention to what we put in our mouths every day.

In recent years, the public’s interest in food has been increasing in Korea, which can be seen from the fact that there are many food programs on TV. Although these food-related TV programs are positive in that such programs increase public interest in food and provide easy information for cooking, there is a problem in how the economic, social, ecological and ethical aspects of food are overlooked. By focusing on the appearance and taste of food, the workers who produce the ingredients, the environment, and our relationship with our bodies are excluded from the public’s consideration. School education, unlike the mass media, must not overlook these educational elements when dealing with food.

In secondary school education, food is primarily addressed in terms of nutrition and food safety, especially in home education courses, but it has also been an important topic in geography. Recently, in the field of home education, the emphasis on the transition from food and nutrition to education on the food system has been emphasized (Sadegholvad et al., 2017), which indicates a geographical shift in home education. The development of geography education using recent food geography components is a continuous and demanding process. Before developing such content, the food-related factors in the current school geography curriculum and textbooks must be examined and analyzed. A content analysis of geography curriculum and textbooks can serve as a basis for improving geography education using food geography (Kondracki et al., 2002). Therefore, it is necessary to examine how food-related factors are represented in the geography curriculum and textbooks.

In this study, we will reveal the structural characteristics that reflect food geography-related factors in an International Baccalaureate Diploma Program (IBDP) geography textbook and a Korean world geography textbook through a semantic network analysis, which is a computer-based content analysis technique, and present some implications for geography education.

The purpose of the present study is to extract structured forms of information from food-related textual data in the chosen textbooks to visually represent patterns and meaning and to identify semantic networks. The research questions in this study are as follows. 1) What are the keywords that appear in food-related texts in the selected geography textbooks? 2) What structural characteristics does the semantic network of keywords in food-related text in the selected geography
textbooks have, and what meaning does the semantic network have? 3) What similarities and differences between the keywords in the two textbooks do the semantic networks show?

2. Theoretical background

2.1. The geography of food

Food is a human daily necessity—not only a means for human survival but also a symbol of humanity’s life, culture, and history. Food is also an important topic in education because it can lead to social, health, and environmental costs rather than just the goods or commodities that humans eat (Lang et al., 2009, p. 1). Consequently, food has received attention from both the physical and the social sciences because it is a bridge between the natural and social worlds.

Geography is similar to food in that it is an integrative discipline that connects physical and human environments. Food is inherently geographical because all food is produced and consumed somewhere; therefore, food has become a notable topic within the discipline of geography, especially human geography. The geography of food focuses on patterns of food production and consumption from the local to the global scale. In particular, it has focused on the unequal relationships between developed and developing countries in relation to the innovation, production, transportation, retail, and consumption of food.

Modern geography initially focused on food as an economic activity, especially in terms of agricultural geography. Agricultural geography focused on the conditions under which crops as the raw material for food were grown and the geographical distribution of production. It was not until the 1980s that geographers turned their attention to food in a wider sense. In the 1980s, geographers brought about the emergence of agro-food geographies to examine food within the food chain along with political and economic approaches (Watts et al., 2005; Winter, 2003). In particular, the discipline has started to pay attention to the many issues that emerge from the food chain. In other words, attention has begun to be paid to the global food system, which is markedly controlled by global capitalism and multinational food companies in the chain leading to the production, distribution, and consumption of food.

With the recent trend of postmodernism or post-structuralism in social science, geography has started to focus more on the consumption than the production of food. Focusing more on consumption than production means a cultural turn in economic geography (Goodman & DuPuis, 2002). The interest in the consumption of food sparked by cultural and economic geographers has served as an occasion to pay attention to cultural essentialism, criticizing the short-sighted economic symbolism of previous economic geography (Winter, 2003). Researchers have begun to pay attention to consumption issues, including the food chain and food system. From this trend being established, food is now the subject of both economic geography and cultural geography.

Recent geography has focused on the notion of everyday life as related to food, which is considered a cultural turn (Jackson, 1989). This is based on a notion based in cultural politics that the everyday consumption of food has political implications. Bell and Valentine (1997) offer a unique discussion of the geography of food in a book titled “Consuming geographies: We are where we eat,” where the authors explore how food relates to the body, home, community, city, region, country, and world, using the social construction of scale by Smith (1993). Their book considers various issues such as body image, food and health, the gendered aspects of food preparation, the role of food in the development of ethnic identity, the construction of national food, local food culture, and food tourism. Emphasizing the social construction of food culture, the aforementioned authors show the meaning of food consumption to be combined with social, economic, political, and moral systems and stress the importance of understanding food's cultural politics. Recently, Howard (2021) addresses the geography of food in terms of concentration and power in the food system by posing the question: “Who controls what we eat?” In addition, Kneafsey et al. (2021) and Joassart-Marcelli (2022) review case studies across countries worldwide.
to discuss the future of food. The authors broaden the scope of geography of food to include place identities, politics of agricultural production, food trade, hunger and malnutrition, food insecurity in economically developed countries, and future scenarios for sustainable food and farming.

2.2. Geography education to foster global and food citizenship

The food system pertains to the entire process of food production and consumption. The pre-industrialized food system is frequently referred to as the traditional food system, whereas the industrialized and globalized food system is termed as the global food system. The transition from a traditional farming society to an industrial society has led to several changes in the food system. Specifically, the production, processing, distribution, and consumption of food under the global food system are conducted at a global scale. In addition, food is gradually produced from unidentified ingredients sourced from other countries rather than local sources. At present, the increase in processed foods, such as global food, fast food, frozen food, and various instant food items, is an example of this system, which exerts a significant impact on human health and the environment (Booth & Caveney, 2015; Chaney & Doukopoulos, 2018; Lang & Heasman, 2004; Schindler, 2010).

In the near future, students should learn about various emerging issues related to global food chains or food systems through geography. Such issues include those related to food production, such as unequal food production, food crisis, food security, climate change, soil and vegetation degradation, overuse of pesticides, water shortage, and other issues related to food consumption, such as obesity and health-related problems, environmental issues, local food insecurity, and animal welfare. Moreover, these issues encompass social ones related to food, such as labor exploitation, animal welfare problems caused by factory-style livestock breeding, nutrition problems among processed foods, food safety and sustainability, health problems, and socially fair food production (Chaney & Doukopoulos, 2018; Cho, 2017; Joassart-Marcelli, 2022; Kneafsey et al., 2021; Sadegholvad et al., 2017). Under the global food system, humans gradually become food illiterate and contribute to the strengthening of the system through food consumption. Therefore, Wilkins (2005) initiated the movement from food-illiterate consumers to food-illiterate citizens.

In a similar vein, the production and consumption of food have become an important issue mainly due to globalization. Geographical insights on food issues focus on food production and consumption as they vary across space, place, and scale in terms of human–environment interaction, that is, from personal to global. Students are challenged to build their understanding of complicated human relations in the following areas: the food they eat; where and why they eat it; where the food is grown; and how it travels to their plate (Barton, 2017; Bell & Valentine, 1997; Coe et al., 2007; Howard, 2021; Joassart-Marcelli, 2022; Kneafsey et al., 2021; Morgan, 2012). Geography education should enhance the understanding of students regarding the geographic relationships that underlie food issues, patterns, and practice. In addition, geography education should increase the understanding of students regarding food as a nexus for evolving local-to-global (and vice versa) economic, social, cultural, political, and environmental relations. Tracking the patterns of these complex food chains through geography education can elucidate the unequal relationship between developed and developing countries in relation to food innovation, production, transportation, retail, and consumption. Moreover, it can help students visualize the global food system in relation to space and place and cultivate their qualities not only as food citizens but also as food consumers (Chaney & Doukopoulos, 2018; Cho, 2017; Sadegholvad et al., 2017; Shifren et al., 2017).

3. Materials and methods

3.1. Subjects

This study is based on the analysis of one textbook in geography, which is an elective of the IBDP curriculum, and one textbook in world geography, which is an elective of Korean high schools. The reason the IBDP geography textbook was selected as a target of comparison against Korean high school world geography is because it was made into an international standard and that the theme of food is treated separately.
The IB program is an internationally accredited school education program developed and operated by the International Baccalaureate Organization (IBO), a Swiss-based non-profit educational foundation. The IB curriculum consists of a Primary Years Program, a Middle Years Program, and a Diploma Program (DP) equivalent to a high school curriculum. The IBDP consists of six subjects and three core courses that students complete over two years. The IBDP geography textbook is included in the “Group 3. Individuals and Societies” module of the six subjects and consists of seven optional themes, three core themes, and three core extension themes around global geography issues. In this study, “Food and Health” was studied among the seven optional themes. The IBDP geography textbooks are published by Cambridge University Press and Oxford University Press. The theme of “Food and Health” that I would like to address herein is one of the optional themes of the IBDP geography textbook, which is only covered in textbooks by Oxford University Press (Nangle & Cooke, 2017); thus, I selected it for our investigation.

In Korea, education is generally conducted using privately published textbooks based on the national curriculum developed by the Korean Ministry of Education. Therefore, textbooks play a crucial role in Korean pedagogical practice. In the current 2015 revised South Korean curriculum, world geography is one of nine general elective courses in social studies. The Korean world geography curriculum consists of eight units, and the fourth topic in Unit 3, “World Humanity Environment and Landscape,” “Major Food Resources and International Movement,” mainly deals with food. Some of the units, including Unit 2, “The World’s Natural Environment and Human Life,” and Unit 5, “Life Adapted to the Natural Environment,” deal partly with food; some of the others, including Unit 2, are partly about food. In Korea, world geography textbooks are published by four publishers, namely, Chunjae Education, Kumsung Publishing Co., Ltd., Kyohak Printing and Publishing Co., Ltd., and Visang Education Inc. The Ministry of Education has subjected these textbooks to rigorous testing to ensure that they accurately match the national curriculum’s success standards. In this manner, their unit system and contents are nearly similar. Thus, only the world geography textbook published by Kumsung Publishing Co., Ltd. (Hwang et al., 2019), which achieved the highest market share and is being used by one of the researchers in classes, was selected for analysis in this study.

3.2. Textbook and semantic network analyses

Textbooks are a means of actualizing and communicating what is described in the curriculum and hold an important position in the realization of said curriculum (Angus, 2004). Textbooks should be able to convey meaningful changes in geographical knowledge as teachers in Korea rely on textbooks to prepare and teach classes. Therefore, whether textbooks faithfully reflect the changes in current geographical knowledge is an important educational issue, which can mainly be determined through content analysis.

Content analysis of textbook focuses on the connection between keywords or conceptual words in messages in the written language, such as text or documents, to form a structure (Kondracki et al., 2002). However, general content analysis was originally conducted by the researcher tasked with selecting, classifying, and linking keywords according to the criteria to uncover structural characteristics between them. For this reason, general content analysis poses a limitation in reducing validity and reliability through excessive reliance on the subjectivity of the researcher (Doerfel & Barnett, 1999; Lee & Ko, 2015). Recently, the use of computer software instead of traditional techniques is increasing to minimize the subjective intervention of researchers and enhance the efficiency, precision, and reliability of analysis (Neuendorf, 2002). Content analysis has also been utilized to further analyze and understand the background of key concepts or keywords formed through integration with qualitative research techniques or the specific meaning and context of the semantic structure formed between them (Hsieh & Shannon, 2005; White & Marsh, 2006).

Alternatively, one method used by computers to analyze the content of textbooks is semantic network analysis, which identifies links between the concepts that constitute sentences (Doerfel & Barnett, 1999). Semantic network analysis is used to extract frequently emerging words from the
text into important concepts and then visualize the relationship between these words as semantic networks by marking with a link how these concepts are interconnected and related as they occupy a position in the text (Drieger, 2013). In this case, the word or phrase, which is the unit of information, is placed within the concept of forming each node, and the connection between the concepts is represented by a link, where the meaning is interpreted through a co-occurrence relationship of the words revealed by the link. Therefore, semantic network analysis is advantageous as it can easily and methodically be used to understand structural relationships between concepts (Jang & Barnett, 1994; Lee, 2014; Lee & Ko, 2015; Park & Leydesdorff, 2004; Stempler, 2001). In other words, as a method of content analysis of textbooks, semantic network analysis is useful for identifying the frequency of keyword use in textbooks, links between keywords (nodes), and network (structure) connection. Conversely, conducting a semantic network analysis of the curriculum and textbooks is meaningful as it can effectively elucidate the actual semantic structure of the text. However, it is difficult to conclude that this method solely can grasp the characteristics or structure of the curriculum and contents of textbooks. Despite the aforementioned advantages, semantic network analysis also presents difficult aspects in terms of the full analysis of elements, such as qualitative meanings inherent in the context of the text, because it focuses on the semantic structure of text using computer software (Lee, 2014; Lee & Ko, 2015; Park & Leydesdorff, 2004). Nevertheless, semantic network analysis is effective in visually confirming the type of network structure formed for a specific topic by analyzing structural relationships between words. However, because the results are interpreted through semantic relationships between words, a limitation exists in determining whether the relationship is correct or incorrect.

Semantic network analysis yields analysis indicators such as density, degree centrality, and betweenness centrality. Density represents how many relationships all the concepts in the network have. Degree centrality is a quantitative indicator of how much one word relates to other words and is located at the center of the network. Betweenness centrality measures whether one concept acts as an intermediary in constructing a network with another. The higher the betweenness centrality of a concept is, the more the concept serves as an important intermediary for information flow and exchange across the entire network.

3.3. **Data collection and analysis**

3.3.1. **Data collection: transcription and processing**

Only the text of the food-related units of the two textbooks was transcribed into English and Korean files. Semantic network analysis considers the concepts presented together in a sentence to be related and connects each concept to the others, so it is entered in sentence form. The contents of the text entered in sentence form were selected; only meaningful concepts through the preprocessing process were stored, namely, a refinement that removes postpositions, predicates, conjunctions, and exclamations. The concepts were all selected based on nouns, but adjectives (e.g., global) that had meanings in relation to food, even if they were not nouns, were conceptualized. Because the present research comprises a study of textbooks, when selecting and extracting concepts, only the concepts as they were presented in textbooks were extracted, that is, without the opinions of the researchers. Two teachers, who have written high school world geography textbooks and have worked for more than 10 years, excluded concepts that were not important in the classroom. The number of concepts that were extracted as a result of preprocessing was 126 for the IBDP geography textbook and 73 for the Korean world geography textbook.

3.3.2. **Semantic network analysis: visualization**

Here, I use KrKwic and UciNet, software developed for the content analysis of Korean and English texts for semantic network analysis (Figure 1). KrKwic is a program co-developed by Professor Park Han-woo of Yeungnam University in Korea and Professor Loet Leydesdorff of the University of Amsterdam in the Netherlands, which performs word-frequency analysis to find and identify all the words used in an analyzed message and then calculates the number of times each word has been used (Park & Leydesdorff, 2004).
The procedure for analyzing semantic networks using KrKwic is as follows. A list of frequently emerging words was produced by extracting text from the “Food” unit of the geography textbook published by Oxford University Press and the “Food” unit of the world geography textbook published by Kumsung Publishing under the “krwords.exe” program. In this process, it is necessary to convert capital letters into lowercase letters to increase the accuracy of the analysis. A list of frequently emerging words was calculated in the “wrdfrq.txt” file wherein a refinement was performed to replace the frequently emerging words with different words that had the same meaning as the original words. In this study, I extracted around 35 keywords by referring to prior studies related to semantic network analysis. Keywords were selected from terms that appeared with a high frequency, which were considered to be highly related to “food.” As the next step in selecting the keywords, the frequency matrix of the co-occurrence relation between keywords was calculated through KrKwic’s “krtitle.exe” program.

After uploading the frequency matrix Excel file derived via KrKwic to UciNet, a program that visually analyzes the social network, I ran NetDraw to visualize the network structure formed between the keywords as a semantic network. In a semantic network visualized through NetDraw, the more a node sits in the middle, the more it occupies a central position in the entire structure of the text. The thickness of the lines connecting each node indicates the strength of connection between the keywords; the thicker the line is, the stronger the connection between the words is. The size of a node represents the frequency of occurrence of certain keywords; the larger the size is, the more frequently mentioned the keywords are.

By interpreting the structural characteristics of food-related content in these textbooks from the perspective of the geography of food, our study seeks to specifically and structurally examine how these textbooks reflect the characteristics and factors of the geography of food.

4. Results

4.1. Geography in the IB DP curriculum

4.1.1. Frequency of keywords
Using the KrKwic program, the “Food and Health” unit of the IBDP geography textbook was analyzed, and the list and frequency of a total of 35 keywords were finally derived, as shown in Table 1. The most frequently identified keywords were food, followed by health, countries, disease, and global. Based on this frequency, the text is believed to be dealing in depth with the connection between food and health and disease. The keyword to support this is access, which has the 10th highest frequency of appearance, indicating that differences in access to food lead to health and disease. Our study shows that the textbook focuses on how the relationship between food and health differs from country to country at a global level, namely, on global inequality in food and health.
Table 1. Frequency of keywords in the IBDP geography textbook’s “Food and Health” unit

| Keywords     | Frequency | Keywords      | Frequency | Keywords       | Frequency |
|--------------|-----------|---------------|-----------|---------------|-----------|
| food         | 171       | energy        | 22        | farmers       | 12        |
| health       | 90        | diffusion     | 19        | national      | 12        |
| countries    | 79        | ranching      | 19        | physical      | 12        |
| disease      | 77        | security      | 19        | high-income   | 11        |
| global       | 58        | life          | 17        | lack          | 11        |
| malaria      | 49        | meat          | 17        | sanitation    | 11        |
| mortality    | 36        | nutrition     | 16        | diet          | 10        |
| agricultural | 32        | crops         | 15        | expectancy    | 10        |
| children     | 29        | hunger        | 15        | water         | 10        |
| access       | 28        | burden        | 14        | low-income    | 8         |
| death        | 28        | developing    | 14        | power         | 8         |
| women        | 27        | market        | 14        | protein       | 8         |
| care         | 23        | spread        | 14        | share         | 8         |
| poor         | 23        | consumption   | 13        | treatment     | 8         |
| production   | 23        | intake        | 13        | environmental | 7         |

Categorizing a total of 35 keywords among similar attributes can reveal distinct trends. Food, the most frequent core word, is a central keyword, and the difference in access to food is described in terms of region, gender, economy, and power through keywords such as access, countries, security, burden, developing, intake, national, high-income, lack, low-income, power, and share. Differences in access to food result in differences in health. Keywords that prove this relationship include disease, malaria, mortality, children, death, women, care, poor, diffusion, life, nutrition, hunger, spread, sanitation, diet, expectancy, protein, and treatment. Furthermore, keywords such as agricultural, production, energy, ranching, meat, crops, market, consumption, and farmers are closely related to agro-food geography (Watts et al., 2005; Winter, 2003), which mainly deals with the food system, and are also frequently used. Keywords such as water and environmental, which represent the relationship between food and sustainable agriculture, are relatively lower in number and proportion than other keywords but are also treated as an important part. This is because the process by which humans produce, distribute, and consume food affects the environment.

4.1.2. Analysis of semantic network and degree centrality of keywords

Using NetDraw, as provided by UCINet (version 6), the semantic network of keywords is derived as shown in Figure 2. In semantic networks, the higher the centrality within the text structure is, the more central the keyword is, and the thickness of the line that connects the keywords is proportional to the degree to which the linked keywords are interconnected. It can be interpreted that the fewer the number of lines connected to the other keywords are and the thinner the lines connected are, the more peripheral is the position that the keyword occupies in the full text. Moreover, the size of a node is proportional to the degree of entry to that node, meaning that the larger the node is, the closer it is to the connected keywords (ONA Surveys, 2009, p. 2, 8; Wasserman & Faust, 1994, pp. 126–128).

Figure 2 shows that the keywords located at the heart of the semantic network are food, access, global, national, country, and so on, which identify patterns of connection with other keywords. The figure shows that the textbook focuses on identifying national differences in food access at the global level. Health, the next most frequent word after food, forms the right-hand side of the semantic network with disease, life, death, mortality, sanitation, malaria, burden, expectancy, share, treatment, and so on. In the lower right corner of the semantic network, keywords such as protein, care, diet, and nutrition form a semantic network with food and health. In addition to...
what was mentioned earlier, this proves that the textbook focuses on the differences in access to food at the global level and the resulting variations in health. Furthermore, agriculture, security, water, crops, farmers, physical, ranching, consumption, production, market, energy, meat, etc., are concentrated on the left side of the semantic network and are closely connected to food. Thus, the textbook deals with the food system as another important aspect. The term environmental is linked to agriculture, which suggests that the textbook also focuses on sustainable agriculture.

These structural features are more clearly identified by the connection strength of the keywords listed in Table 2 and the degree centrality of the keywords listed in Table 3. Keywords such as food, country, access, global, and national, which occupy a central position in the semantic network, also rank high in connection strength and degree centrality scores. In other words, the food-related unit of the IBDP geography textbook can be interpreted to have structural features that link related keywords and elements around keywords such as food, health, access, global, and national, as shown in Figure 2.

4.2. Korean world geography

4.2.1. Frequency of keywords
Using the same process as the analysis of the IBDP geography textbook, I analyzed the food-related units of the Korean world geography textbook and extracted the list and frequency of 35 keywords, as shown in Table 4. Of the total 35 keywords, region appeared the most frequently with 28 instances, followed by many (20 times), grains (14 times), climate (14 times), cultivation (14 times), and agriculture (13 times).

Among the keywords, region and many appeared the most frequently, which seems to be closely related to how the Korean world geography textbook focuses on the regional distribution and quantity of food. This is also evidenced by the fact that the keyword weight is frequently used. Further, keywords such as grain, agriculture, breeding, rice, wheat, pigs, rice, corn, livestock, ranching, nomads, meat, crops, food, and resources are frequently mentioned, indicating that food is often used in terms of agricultural resources and raw materials. It can be inferred that the Korean world geography textbook treats food as a resource or raw material and focuses on the quantitative identification of the regional distribution of food as such a resource or raw material. In
addition, keywords such as cultivation, production, consumption, transportation, international, demand, import, population, corporate, and commercial are used, from which it can be inferred that the focus is on food production, consumption, and transportation as resources or raw materials. Thus, the Korean world geography textbook focuses on quantitative aspects such as the production, consumption, and movement of food as a resource.

Keywords such as climate, winter, monsoon, dry, precipitation, Mediterranean, and natural environment also appear frequently, indicating that the Korean world geography textbook focuses on

### Table 2. Connection strength of keywords in the IBDP geography textbook’s “Food and Health” unit

| Keywords  | Connection strength | Keywords  | Connection strength | Keywords  | Connection strength |
|-----------|---------------------|-----------|---------------------|-----------|---------------------|
| food      | 5.263618            | poor      | 2.625664            | burden    | 1.640173            |
| diet      | 4.050776            | production| 2.612878            | environmental| 1.611655            |
| health    | 3.955129            | protein   | 2.576698            | lack      | 1.606592            |
| country   | 3.725564            | expectancy| 2.497487            | sanitation| 1.533164            |
| disease   | 3.649378            | developing| 2.495106            | malaria   | 1.50404             |
| nutrition | 3.395479            | death     | 2.413072            | hunger    | 1.489169            |
| access    | 3.358133            | care      | 2.375714            | water     | 1.422761            |
| women     | 3.27237             | crops     | 2.249659            | intake    | 1.355614            |
| children  | 3.195699            | consumption| 2.130979           | farmers   | 1.217349            |
| life      | 3.095624            | mortality | 1.991892            | ranching  | 1.193862            |
| market    | 2.972541            | security  | 1.964197            | power     | 1.191398            |
| global    | 2.957478            | energy    | 1.864317            | meat      | 1.116601            |
| Africa    | 2.846115            | spread    | 1.683643            | treatment | 1.030692            |
| national  | 2.653385            | agricultural| 1.671763           | diffusion | 1.013488            |
| physical  | 2.630589            | share     | 1.64718             | sub-Saharan| 0                  |

### Table 3. Degree centrality of keywords in the IBDP geography textbook’s “Food and Health” unit

| Keywords | Degree centrality | Keywords | Degree centrality | Keywords | Degree centrality |
|----------|-------------------|----------|-------------------|----------|-------------------|
| food     | 82%               | water    | 62%               | sanitation| 42%               |
| global   | 80%               | poor     | 60%               | share    | 42%               |
| country  | 73%               | care     | 58%               | mortality| 40%               |
| disease  | 73%               | security | 53%               | spread   | 38%               |
| nutrition| 73%               | crops    | 53%               | power    | 36%               |
| diet     | 73%               | energy   | 51%               | farmers  | 33%               |
| health   | 71%               | protein  | 51%               | environmental| 33%            |
| women    | 71%               | physical | 49%               | meat     | 29%               |
| Africa   | 71%               | death    | 47%               | hunger   | 29%               |
| children | 69%               | developing| 47%              | burden   | 29%               |
| access   | 69%               | lock     | 47%               | expectancy| 29%              |
| national | 67%               | agricultural| 44%             | diffusion| 24%               |
| production| 64%             | ranching | 44%               | intake   | 24%               |
| life     | 62%               | malaria  | 42%               | treatment| 20%               |
| market   | 62%               | consumption| 42%             | sub-Saharan| 0               |
on regional differences in food according to the natural environment (especially climate). The Korean world geography textbook deals with human life as influenced by the natural environment from the perspective of ritualism, especially in tropical, hot, monsoon, and dry areas.

4.2.2. Analysis of semantic network and degree centrality of keywords

The semantic network, connection strength, and degree centrality of the food-related units of the Korean world geography textbook derived from the previous section are derived in the same manner as in the case of IBDP geography, as shown in Figure 3, Table 5, and Table 6.

Figure 3 shows that keywords such as region, grain, and agriculture are located at the center of the semantic network. As a result of deriving the connection strength of the keywords, as shown in Table 5, the keywords located at the center of the semantic network are consistent with region and grain, which are keywords with high connection strength. Furthermore, the degree centrality is derived, as shown in Table 6, indicating that the keywords located at the heart of the semantic network are consistent with the keywords of region, agricultural, wheat, grain, climate, and production.

From these results, it can be seen that food-related units of the Korean world geography textbook emphasize regional distribution, mainly by treating food as a resource for agricultural products. Moreover, “many” is located right above the “region” that forms the center of the semantic network, which means that the textbook primarily deals with the distribution of agricultural products as resources. On the left side of the semantic network, keywords such as dry, Mediterranean, winter, precipitation, rice farming, monsoons, wheat, corporate, ranching, nomads, breeding, and meat form a network deriving from climate. Thus, the Korean world geography textbook mainly considers differences in agriculture and food culture according to the natural environment. Conversely, on the right side of the semantic network, keywords such as resources, food, consumption, production, rice, population, weight, international, transportation, demand, import, pigs, and livestock form a network from crops. This shows that food is related to production, distribution, and transportation as it is treated as a resource or raw material.
5. Discussion: Comparison between IBDP Geography and Korean World Geography from the perspective of global and food citizenship

Our study found that the structural characteristics of the semantic network of the keywords in the food-related texts of the IBDP geography textbook and the Korean world geography textbook are considerably different and that different semantic networks have different meanings. Here, I want to compare the different structural characteristics and meanings of the keywords in the food-related text of these two textbooks from the perspective of food geography and discuss the meanings of each for geography education. Subsequently, I aim to suggest the directions in which geography education through food should be developed.

![Figure 3. Semantic network of the food-related units of the Korean world geography textbook.](image)

| Keywords     | Connection strength | Keywords     | Connection strength | Keywords     | Connection strength |
|--------------|---------------------|--------------|---------------------|--------------|---------------------|
| region       | 11.09206            | corn         | 6.703078            | ranching     | 4.058456            |
| grains       | 9.512282            | natural environment | 6.471236     | commercial | 4.041382            |
| wheat        | 9.186087            | crops        | 6.310047            | rice farming | 3.925027            |
| climate      | 9.074783            | demand       | 6.228578            | monsoon     | 3.731927            |
| production   | 8.757502            | international | 6.053225    | winter      | 3.637433            |
| cultivation  | 8.417116            | transportation | 6.015427   | livestock   | 3.309957            |
| dry          | 8.183931            | breeding     | 5.187955            | Mediterranean | 2.783117           |
| resources    | 7.846524            | rice         | 4.817373            |             |                     |
| many         | 7.795227            | meat         | 4.699061            |             |                     |
| weight       | 7.725247            | nomads       | 4.533027            |             |                     |
| agriculture  | 7.656914            | precipitation | 4.443118   |             |                     |
| population   | 6.896493            | consumption  | 4.311343            |             |                     |
| import       | 6.818565            | pigs         | 4.099375            |             |                     |
| food         | 6.785277            | corporate    | 4.058456            |             |                     |
As the results revealed, the IBDP geography textbook showed that keywords such as food, health, countries, global, and access were frequently introduced, and the degree centrality was high. By contrast, in the Korean world geography textbook, keywords such as region, grains, crops, and agriculture appeared frequently, and the degree centrality was high. Here, I would like to discuss the differences by comparing the connection strength with other terms, focusing on the keywords food and place, both of which are commonly emphasized by the two textbooks.

First, in the IBDP geography textbook, food has both a high frequency of appearance and degree centrality; however, in the Korean world geography textbook, food has less frequency and degree centrality than in the IBDP geography. In the IBDP geography textbook, food was highly connected to keywords such as security, diet, production, nutrition, hunger; in the Korean world geography textbook, conversely, food was highly connected to keywords such as resource, production, meat, grain, and natural environment (Table 7). This allows the IBDP geography textbook to identify health-related content such as food security, nutrition, and hunger, while the Korean world geography textbook shows that food is used as an indicator of resources and cultural differences according to the natural environment.

Moreover, the most frequently used terms related to place were “country” in the IBDP geography textbook and “region” in the Korean world geography textbook. These keywords were frequently used in both textbooks and had a high degree of centrality; however, as with food, keywords with a strong connection differed greatly from each other.

Table 6. Degree centrality of keywords in the food-related units of the Korean world geography textbook

| Keywords   | Degree centrality | Keywords   | Degree centrality | Keywords   | Degree centrality |
|------------|-------------------|------------|-------------------|------------|-------------------|
| region     | 97%               | weight     | 57%               | meat       | 37%               |
| agriculture| 86%               | population | 57%               | monsoon    | 34%               |
| wheat      | 83%               | international | 54%             | rice farming | 34%               |
| grains     | 80%               | consumption | 54%             | nomads     | 31%               |
| climate    | 80%               | natural environment | 54%             | Mediterranean | 29%               |
| dry        | 77%               | livestock  | 46%               | corporate  | 23%               |
| production | 77%               | pigs       | 46%               | ranching   | 23%               |
| cultivation| 74%               | breeding   | 46%               |           |                   |
| crops      | 69%               | transportation | 46%             |           |                   |
| many       | 66%               | precipitation | 40%             |           |                   |
| food       | 66%               | winter     | 37%               |           |                   |
| resource   | 66%               | commercial | 37%               |           |                   |
| rice       | 63%               | demand     | 37%               |           |                   |
| corn       | 60%               | import     | 37%               |           |                   |

Table 7. Keywords with a strong connection with “food”

| IBDP geography | Korean world geography |
|----------------|------------------------|
| security       | 0.365324               | resources             | 0.864356   |
| diet           | 0.345325               | production            | 0.619125   |
| production     | 0.281654               | meat                  | 0.586542   |
| nutrition      | 0.277368               | crops                 | 0.572643   |
| hunger         | 0.220654               | natural environment   | 0.504768   |
The IBDP geography textbook’s “country” had a strong connection with keywords such as developing, global, food, women, and health, whereas the Korean world geography textbook’s “region” had a strong connection with terms such as dry, weight, climate, cultivation, and many (Table 8). In the IBDP geography textbook, the term “country” had a strong connection with terms such as development, gender, and health at the global level, while the Korean world geography textbook had a strong connection with terms related to differences in food culture owing to the natural environment, including crop production and production area.

Based on the comparative analysis results of the two textbooks above, we would like to discuss their position in terms of food geography and global and food citizenship as viewed from a theoretical background and their meanings and implications for food-based geography education.

To begin with, I would like to discuss the food-related content of the IBDP geography textbook. The most prominent feature of this curriculum and textbook is that food is connected to health. Human beings differ in quality of life, especially in health, because of differences in access to food, and this curriculum and textbook explore spatial inequality by various factors (economic wealth, class, gender, etc.) at the global level. This can be interpreted to be partly a result of the cultural turn regarding food (Bell & Valentine, 1997; Goodman & DuPuis, 2002; Howard, 2021; Jackson, 1989; Joassart-Marcelli, 2022; Kneafsey et al., 2021; Smith, 1993), reflecting postmodern or post-structural trends. In other words, the curriculum and textbook focus on food and health, exploring how food relates to the body, home, community, city, region, country, and the world and using the concept of the social construction of scale (Smith, 1993). The curriculum and textbook recognize the dignity and freedom of the “subject” of producing and consuming food rather than the general and stereotypical “structure” of food and address how various subjects approach food and health as well as the consequences of those approaches. Second, the curriculum and textbook also focus on the food chain and food system, which can be interpreted to partly reflect agro-food geography (Watts et al., 2005; Winter, 2003). Third, the curriculum and textbook focus on the environmental aspects of global capitalism and multinational food companies’ excessive involvement in food chains or food systems.

Through the above discussion, the meaning and implications of food geography reflected in the IBDP geography textbook are discussed as follows. First, the curriculum and textbook emphasize the importance of global inequality in food and health and food security based on the cultural turn regarding food, which can encourage students to cultivate global citizenship and food citizenship (Baker, 2004; Booth & Coveney, 2015; Cho, 2017; Renting et al., 2012; Schindler, 2010; Shifren et al., 2017; Welsh & MacRae, 1998; Wilkins, 2005). Second, having students track food chains or food systems through geography education helps them understand the unequal relationship between developed and developing countries regarding food innovation, production, transportation, retail, and consumption. Third, it allows students to comprehend the global food system in relation to space and place and develop their qualifications as food citizens, not just as consumers of food (Barton, 2017; Bell & Valentine, 1997; Cho, 2017; Coe et al., 2007; Morgan, 2012; Shifren et al.,

| Table 8. Keywords with a strong connection with place-related terms |
|---------------------------------------------------------------|
| **Connection strength of connection of “country” in the IBDP geography textbook** | **Connection strength of “region” in the Korean world geography textbook** |
| developing | 0.386432 | dry | 0.657411 |
| global | 0.317225 | weight | 0.600245 |
| food | 0.201784 | climate | 0.594564 |
| women | 0.139567 | cultivation | 0.553446 |
| health | 0.116235 | many | 0.514496 |
Global citizenship and food citizenship education through food might be sufficient to foster the learning elements and capabilities needed to encourage talent that can contribute to the IB's educational goal of realizing a better and more peaceful world (IBO, 2017).

In addition, I would like to discuss the food-related content of the Korean world geography textbook. First, in the Korean world geography textbook, food is treated as a resource or raw material, focusing on a quantitative notion of access to its regional production and distribution, movement, and consumption. Second, it focuses on regional characteristics and differences in food culture according to the natural environment (particularly climate). Thus, the Korean world geography textbook remains within the context of agricultural geography, a subfield of economic geography, in terms of food geography (Morgan, 2012; Winter, 2003). In other words, the Korean view of food in the world geography textbook emphasizes aspects of resources and distribution, and the origin, distribution, transportation, and consumption of food production are interpreted through quantitative analysis to identify regional characteristics.

From a geographical education perspective, this can contribute to acquiring geographical knowledge and information, including the geographical distribution, production, consumption, and transportation of food, and to increasing students' understanding of the diversity of food culture around the world. However, such an interpretation is limited in terms of developing global citizenship competencies to critically view and provide solutions to various issues around the world around the food system.

Food-based geography education should encourage students to foster food citizenship. Food citizenship education through geography is crucial because food citizenship education can address concepts such as health, climate change, biodiversity, animal welfare, local economic development, and social justice (Chaney & Doukopoulos, 2018; Howard, 2021; Joassart-Marcelli, 2022; Jones et al., 2012; Kneafsey et al., 2021) and ultimately allow students to engage in food issues and possibly participate in alternative food systems (Cho, 2017; Sadeghohbad et al., 2017; Shifren et al., 2017). According to Morgan (2012), geography education that fosters food citizens who reflect on food and devote themselves to alternative food systems should shift from teaching about the geography of agriculture to teaching about the cultural geographies of food.

5. Conclusion
In this study, I identified the structural characteristics of food-related content as represented in the IBDP geography textbook and the Korean world geography textbook through a semantic network analysis and compared the similarities and differences thereof. Both textbooks are interested in global issues and aim to foster talented individuals who can contribute to solving these problems. Moreover, I analyzed the structural characteristics of the relevant components through semantic networks around the material of food, leading to different results.

The IBDP geography textbook dealt with differences in access to food at a global level, food security, relationships between food and health, food systems, and food and environmental issues as important learning factors. By analyzing its food-related unit, I identified its usefulness as a learning resource that can contribute to fostering global citizenship and food citizenship. Conversely, the Korean world geography textbook treated food as a resource and focused on empirical interpretations of related quantitative data. Therefore, the Korean world geography textbook focuses on intellectual learning in relation to the quantitative distribution of food as a resource and is thus limited in terms of its development of global citizenship. The Korean world geography textbook is not sufficient in and of itself to encourage learners to become food citizens by learning about food.

Based on our results, I present the following recommendations. Geography education based on food should focus on transforming students into food citizens rather than food consumers. Food is an important educational material that stimulates interest in geographic learning and facilitates
entry into various geographical concepts; however, it must focus not only on learning about food distribution and diversity but also on questioning the various issues hidden in the food system.

Conversely, semantic network analysis, which is the research methodology employed by this study, has certain limitations. For example, despite various advantages, it is unable to entirely analyze factors such as the qualitative meanings inherent in the context of the text. To systematically and comprehensively reveal the contents of the geography of food in world geography textbooks from the perspective of global citizenship and food citizenship, follow-up studies should be conducted to supplement the abovementioned limitations.

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