

Teaching Spatial Thinking with the National Atlas of Korea in U.S. Secondary Level Education

Gregory H Chu,^a Chul Sue Hwang,^b and Jongnam Choi^c

^a University of Wisconsin-La Crosse, La Crosse, Wisconsin, USA; chu.greg@eagle.uwlax.edu

^b Kyung Hee University, Seoul, Korea; hcs@khu.ac.kr

^c Western Illinois University, Macomb, Illinois, USA; j-choi1@wiu.edu

Abstract: This paper is predicated on the body of literature that supports a theoretical concept that middle and high school age children possess the cognitive ability to understand thematic maps and achieve some degree of cartographic literacy. In 2006, the US National Research Council (NRC) of the National Academies published a landmark book on Learning to Think Spatially. This book documented essential secondary education components and various aspects of teaching spatial thinking. The NRC defines spatial thinking as “a form of thinking based on a constructive amalgam of three elements: concepts of space, tools of representation, and processes of reasoning” (NRC, 2006, ix). This paper is an attempt to document and understand some of the attributes associated with these three elements. Specifically, it aims to find ways that can effectively contribute to the teaching of these elements associated with spatial thinking. The National Atlas of Korea is chosen for lesson plan development because it is well-designed and provides a range of contents and comprehensiveness that are ideal; in addition, it is freely accessible online and downloadable (<http://nationalatlas.ngii.go.kr/>). Four master geography teachers were invited to examine the Atlas to conceive and develop Advanced Placement Human Geography (APHG) lesson plans. Four lesson plans were written and have continually been implemented in classrooms to over 800 students in the States of Utah, Georgia, Minnesota, and Tennessee since the 2015 Fall semester. Results are presented in this paper.

Keywords: Teaching, Spatial thinking, The National Atlas of Korea, secondary education, lesson plans

1. Introduction

Research attempts to unravel how children understand maps date back decades. Geographers, cartographers, and psychologists played important roles on this research topic. Several pioneers in the 1970s and 1980s who contributed literature on this topic include Barbara Petchenik, Rod Gerber, Henry Castner, Jean Piaget, Roger Downs and Lynn Liebens. In the mid-1990s and with the early initiation of Geographic Information Systems (GIS) into some secondary schools, a movement in the geographic education community in the United States to prioritize an understanding on children’s cognitive spatial ability introduced the field of “Spatial Thinking.” The body of literature from the mid-1990s to today recognizes spatial thinking as a more involved thinking process that focuses on spatial components and spatial reasoning. In 2006, the National Research Council in the U.S. published a landmark book titled Learning to Think Spatially: GIS as a support system in the K-12 curriculum which would set a foundation for cartographic, GIS, visualization, and spatial thinking parameters for teaching secondary geographic education in the U.S. (NRC; 2006). The book defined spatial thinking as “Spatial thinking—one form of thinking—is based on a constructive amalgam of three elements: concepts of space, tools of representation, and processes of reasoning.” Since its publication, other relevant pieces of work were authored by Gersmehl (2008), Lee and Bednarz (2012), Huynh and Sharpe

(2013), Santos (2015), Duarte (2015), and Chu et.al. (2016).

2. Goals

This paper seeks to construct a secondary education level curriculum that incorporates all three elements in the NRC amalgam. The concept of space shall be the obvious central theme for the lesson plans to be developed by middle and secondary school teachers. The tools of representation adopted for this project are thematic maps from The National Atlas of Korea, which also include a broad spectrum of graphics, photographs, tables, charts, and satellite images—a perfect array of media for secondary geographic education. Lessons plans are to be created to include spatial reasoning, critical thinking, and spatial thinking questions that students are required to answer.

Students will also be asked to raise spatial questions rather than to just answer them. The primary goal is to improve the educators’ ability and skills in teaching spatial thinking and the ability of students to grasp spatial concepts and to develop spatial thinking and reasoning skills. The secondary goal is to expose students to a country, Korea, and its geographic attributes which are seldom taught in North American secondary classrooms. The tertiary goal is to add content materials to a nationwide program called Advanced Placement Human Geography (APHG) in accordance with various state standards. The APHG program in the U.S. allows

secondary students to test out for university credits when they advance to a higher level.

3. The Working Scheme

At the beginning, thoughts were carefully given to the training spatial thinking techniques to secondary teachers (who will join this project) to ensure that they have the necessary map interpretation and cartographic skills to render meaningful lesson plans. This can be a time-consuming process. Instead, a decision was made to select and invite master teachers who have proven geographic and cartographic backgrounds and with a robust teaching experience. Four teachers, Doug Andersen (Oak Canyon High School, Utah), Ken Keller (Walton High School, Georgia), Michael Robinson (Houston High School, Tennessee), and Kelly Swanson (Johnson Senior High School, Minnesota) were invited (and accepted) to examine The National Atlas of Korea in an effort to develop appropriate lesson plans that they can implement in their own classrooms as well as share these plans in the public domain with all teachers who choose to adopt them. These four teachers also had the opportunity to travel to Korea for a few weeks to study the country's geographic settings.

4. The Lesson Plans

Careful examinations of all the maps and associated media from the Atlas were conducted by all four teachers as they contemplate and formulate their own lesson plans. The 177-page Atlas is full of geographic information, thematic maps of various complexities, statistics, charts and graphs that cover numerous themes in national, regional, and community scales. The themes of the maps range from simple physical settings, to national voting patterns, to development of the land and infrastructures through time, to economic well beings, to happiness index, to Korea's connection to the world, and to many more topics. It is a treasure trove of geographic information and knowledge about a nation that is not studied very much in the U.S.; thus, the selection of the Atlas also fills a void in the U.S. secondary curriculum in addition to its appropriateness for map interpretation. Additionally, the entire Atlas is freely accessible online to all, teachers and students alike (<http://nationalatlas.ngii.go.kr/>).

The four teachers were free to choose the topics that they see would stimulate their students' thinking. Four lesson plans were written.

1) Doug Andersen's lesson plan: Talking SMAC: A case study of Sejong Metropolitan Autonomous City and the impact of development and urbanization in South Korea (Abstract: Students use a variety of primary and secondary sources including the new National Atlas of Korea to investigate the impact of development and urbanization on the selection and creation of Sejong Metropolitan Autonomous City as the home of 36 government agencies in South Korea. Students present the advantages and disadvantages of

creating a new government center in a class role play debate and propose solutions to some of the problems associated with this type of regional development model.)

2) Ken Keller's lesson plan: Utilizing the National Atlas of Korea Global diffusion of Korean culture and associated societal impacts: An analysis of Culture and Quality of Life in South Korea (Background or Introduction: Cultural or spatial diffusion is the process of the spread of an idea or innovation from one culture to another. This process is more likely to occur from cultural hearths [origins of culture traits], or centers of culture that are closer in proximity to each other. With the rise of globalization and technology, the spread of culture through the geographic process of space-time compression is more prevalent than ever before. As noted, barriers to cultural diffusion may include time and distance it takes for the ideas to travel, known as time distance decay or space-time compression, as well as the prevailing attitudes and taboos which might hinder the adoption of new culture. South Korea is an ideal case study to examine both elements of unique culture and cultural diffusion. As a dominant economic power/tiger in Asia, South Korea is no stranger to the forces of foreign influence and cultural diffusion. Yet as a modern industrialized country who has embraced globalization, they have also begun to export many elements of their vibrant and unique culture to other parts of the world. In examining South Korean culture, both the rise of global influences within their borders as well as their own influence in foreign lands can be readily observed.)

3) Michael Robinson's lesson plan: South Korea's Population Reality: Using The National Atlas of Korea in Population Geography (Introduction: The following includes seven activities teachers can use that incorporate The National Atlas of Korea. Each of the activities will use map(s) and/or graph(s) from the Atlas. The first two activities introduce students to some of the impressive maps found in The National Atlas of Korea. In Activities 3-6 students will need to use the Atlas to complete each of the short activities. In Activity 7 the Atlas is used in a population lesson to enhance student understanding of the population reality found in South Korea).

4) Kelly Swanson's lesson plan: Korean Development – Where/When/ and Why? (Overview: Development is a loaded word in geography that can be different at different scales. In this activity, students use different indicators of development using the new Korean National Atlas and determine development objectives based on both national and regional scales. Objectives: Students will analyze the different indicators of development for their effectiveness and validity using the Korean National Atlas at both the national and regional levels.)

In addition, Doug Andersen has also created a document connecting resources from the National Atlas to the 2015 Advanced Placement Human Geography (APHG) Curriculum Articulation. This allows APHG teachers to see immediate connections in the course outline to the resources in the Atlas. That way, teachers can make their own lessons or further the spatial thinking of their students using the Atlas.

These four lesson plans and the APHG Curriculum Articulation in their entirety, along with supplemental materials and PowerPoint presentations of lectures are available for download from <http://nationalatlas.ngii.go.kr/>. Careful documentation on the appropriateness for grade levels, delivery of the plan, learning objectives, and activities are all included. Any teacher may download any or all four lesson plans for implementation in any appropriate level classroom. Individual maps used in these lesson plans can also be downloaded from the Atlas, one page (or even one chapter) at a time. These resources are free and in the public domain.

5. Implementation of Lesson Plans and Summary of Observations

The four teachers have implemented their respective lesson plans in a combined total of 19 times to their classes in the secondary level (9th, 10th, and 12th grades) and twice at the university level with a total of over 800 students. Much of the student activities centered on the interpretation of thematic maps, visualization of patterns, spatial association of phenomena that lead to spatial thinking and spatial correlations.

Given the differences of the lesson plans based on case studies and the difficulty and inconsistencies facing the design of a standard questionnaire or rubrics to gauge student learning across the lesson plans, the teachers opted to individually report student learning results verbally and qualitatively based on their own observations. The following are reported by the teachers as to what the students have generally learned and achieved.

Doug Andersen's evaluation:

- How built landscapes and social space reflect the attitudes and values of a population.
- Measures of development are used to understand patterns of social and economic differences at a variety of scales.
- Planning and design issues and political organization of urban areas.
- How to analyze spatial patterns of economic and social development.
- Sustainable design initiatives include walkable mixed-use commercial and residential areas and smart-growth policies (e.g., new urbanism, greenbelts).

- Models like Rostow's Stages of Economic Growth and Wallerstein's World System Theory help explain spatial variations in development.
- How to analyze primary sources.
- How to look at a topic from different points of view.
- How to read a timeline.
- There were many positive feedbacks from other teachers nationwide on the practical usefulness of the APHG Curriculum Articulation document that tied specific learning tasks to contents of the Atlas.

Ken Keller's evaluation:

- Interpreting thematic maps.
- Understanding the complexity of the relationship between North and South Korea.
- Realizing the importance of Dokdo along with its connection to naming rights. Likewise, the importance of place names and how conflict can be reflected in sport and culture.
- Realizing correlation between population/development variables along with associated changes over time.
- Understanding the importance of spatial analysis, scale and process/pattern over time.
- Becoming better collaborative learners and critical thinkers.

Michael Robinson's evaluation:

- Interpreting thematic maps...Yes, they have used the maps from the Atlas to complete the activities I developed.
- Realized the importance of Dokdo...I have my students read the section on Dokdo to gain an understanding of how important this area is to the Korean people.
- Population patterns, changes, growth, and migration...I have used all of the maps in my lesson to help students better understand the issues facing an aging population.

Kelly Swanson's evaluation:

- By interpreting thematic maps, students gained valuable information in relation to the types of economic development outlined by Dr. James Rubenstein. These types of maps and charts are vital in the development of Advanced Placement Human Geography as more stimulus-based questions are appearing on the multiple-choice section of the (APHG) exam. By giving students more practice it only aids them on the AP exam. (authors' note: Dr. James Rubenstein is author of a major U.S. secondary level human geography textbook)

- By analyzing the different maps, students saw the relationship between North and South Korea in terms of economic development being one factor. Population and demographic factors are important in determining levels of economic development. The maps contained in the Atlas provide great references to scale of economic development in terms of demographic indicators.
- Using this case study approach to problems, students are getting practical application of concepts that are theoretical in nature. This hands-on approach to learning put the theory into context and allows a more concrete knowledge base for our students.
- The textbook, Map Use: Reading, Analysis, Interpretation (Kimerling, Buckley, P. Muehrcke, and J. Muehrcke) was found to be a very useful reference to map reading, interpretation, and analysis skills. It will certainly help teachers with less cartographic training to better understand spatial thinking skills.

As much as there are differences in these lesson plans, there is also a common thread – all four teachers confirm from their observations that students are capable of understanding thematic maps, even with various degrees of complexities. This ability is fundamental to spatial reasoning and analysis. While the spectrum of maps presented on the Atlas is wide, ranging from simple single variable maps to bivariate and multivariate maps to time series maps to quantitative maps and to abstract index maps, overall, the students did not encounter major problems in understanding them with occasional aid and explanation from the teachers. The teachers concurred that students became better collaborative learners and critical thinkers.

6. Conclusion

The initial goals of this project were to construct a curriculum that incorporates all the three amalgams to improve the teaching of spatial thinking; to teach about Korea, the country; and to add content to the APHG program. These lesson plans succeeded in delivering the amalgams of the three components defined by the National Research Council. They have certainly provided content materials to the APHG program that meet state standards in the U.S., albeit for only four lesson plans. The teachers, believing that this effort was very worthwhile, shall continue to implement these lesson plans in future semesters to increase the number of participating students. This project engages more teachers from other states to develop more different spatial thinking lesson plans for implementation. It is hoped that a wider dissemination effort will garner more national attention to the teaching of spatial thinking in U.S. secondary schools. In the aftermath, these teachers are already developing new lesson plans from the subsequent publications of two other national atlases of Korea: 1) The National Atlas of Korea II: Physical Geography, and

2) The National Atlas of Korea III: Human Geography. These two new atlases, published in early 2017, add additional robust contents not only to the APHG program, but also to physical and environmental geography and climate change themes that are part of state standards in US secondary education. Secondary school teachers are encouraged to utilize all three national atlases of Korea for teaching spatial thinking and reasoning.

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