

Cartography Theory and Map Service Model Based on Constructivism

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Abstract. Map is not only the result of geospatial environment cognition, but also a tool for geospatial environment cognition. The new concept advocated by Constructivist cognitive theory is highly consistent with the concept of map service in the era of Internet plus space-time big data. This paper analyzes the geographic information transmission process from the perspective of constructivism, and constructs the geographic information transmission process model. Based on the traditional map cognitive process model, a map cognitive process model based on constructivism is constructed. According to the four elements of “situation, cooperation, communication and meaning construction” advocated by Constructivist cognitive theory, a map service function model based on constructivism is constructed.

Keywords. Cartography, cognitive theory, constructivism, map service, map information

1. Introduction

Map is a reconstructed geographic world and a representation of geographic world modeling. It is a kind of information media that cartographers scientifically obtain and process geospatial information, social information and other related information, and then express it as a kind of information media in line with people’s thinking habits and reading habits. From the objective environment to the map world, from design and production to map recognition, is a typical process of information dissemination. In this process, the factors of cognitive psychology can not be ignored. It is necessary for cartographers to study the law of cognitive psychology and its development frontier.

Constructivism advocates that “the key to effective learning lies in meaning construction”, which fully reveals the thinking process and cognitive law of learning, and is an important methodology in the field of contemporary cognition. It is a kind of thinking and learning activity for users to get information from maps. In depth study of constructivism, a new methodology, has important reference value for the theoretical research of cartography, the practice of map design, and even the promotion of geographic information services.

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2. A Review of Constructivism and Its Comparative Analysis with Traditional Cognitive Theory

The earliest proposer of constructivism theory is Swiss psychologist J. Piaget, whose core view is that “knowledge is neither from the subject nor from the object, the key lies in the interaction between learners and knowledge” [1]. First of all, the original experience is the necessary basis; Secondly, the original experience is not fixed, and the increase of new experience will inevitably lead to its change. With the advancement of learning process, it will be constantly updated and enriched, which is called “two-way construction of subject and object”.

Piaget’s point of view resonates with cognitive psychologists, and several psychologists after him further study and enrich the theory of constructivism. Kohlberg focuses on the characteristics of cognitive structure and its changing conditions; Katz and Sternberg carried out in-depth research on how to stimulate individual subjective initiative; Vygotsky’s main contribution is “the theory of cultural and historical development”, which emphasizes the importance of social, cultural and historical background in learners’ cognitive process, and also puts forward the theory of “zone of proximal development”. There are many different schools of thought in this theory, and their research tendencies are quite different. However, there is a consensus that “knowledge is constructed by cognitive subjects”, and the key to the effectiveness of learning lies in “meaning construction”.

Since the theory of self constructivism was put forward for more than 20 years, it has spread to more than ten countries and regions, across different social backgrounds, involved different levels of education, and covered different disciplines. Studies in many fields show that under the guidance of this theory, learners have significantly improved in knowledge learning, cognitive ability, creative ability, cooperative ability and so on [2].

Constructivism is a new idea in the field of cognition, which puts forward many new ideas and methods, especially on the nature of knowledge, knowledge learning and knowledge structure, which is quite different from the traditional cognitive theory [3]. The guiding theory of cartography has experienced two stages: behaviorism and cognitivism. Constructivism is the further development of traditional cognitive theory. As a new idea in cognitive field, constructivism is more comprehensive, objective and scientific. It deeply reveals the essence, structure and learning principle of knowledge. It is an important theoretical basis for cognitive construction and knowledge learning, and also has reference value for cartography theory and practice.

Table 1 is a comparative analysis of the two main point.

It can be seen from table 1 that as a new idea in the field of cognition, constructivism is more comprehensive, objective and scientific. It deeply reveals the essence, structure and learning principle of knowledge. It is an important theoretical basis for cognitive construction and knowledge learning, and also has reference value for cartography theory and practice.

Table 1. Comparison between constructivism theory and traditional cognitive theory.

Three levels of knowledge	The theory of Constructivism	Traditional cognitive theory
The essence of knowledge	(1) Knowledge is man’s creation of information in the objective world, not a simple mapping. (2) Knowledge is not an accurate representation of reality. With the deepening of learning, it will upgrade the structure, update the connotation, and recreate specific situations.	(1) Knowledge is the reflection of the objective world, the result of cognition, and corresponds with the objective world. (2) The basic characteristics of the objective world are relatively unchanged, and correspondingly knowledge is stable, objective and reliable.
Three levels of knowledge	The theory of Constructivism	Traditional cognitive theory
Knowledge learning	(1) It opposes objectivism’s external shaping theory and holds that learning is a process of interaction between subject and object. (2) Effective learning can only be based on the experience background, and the role of the original knowledge experience basis can not be ignored. Experience includes common sense of life, social phenomena, natural phenomena, and so on.	(1) Learning is the transfer of objective knowledge and the input process of external information. (2) Knowledge is represented by symbolic language, and the cognitive process is to transfer the symbolic language to cognitive individuals so as to acquire knowledge.
The structure of knowledge	(1) It is a complex network system with both structural and non structural characteristics. (2) Knowledge is a network structure around key concepts. Concepts are hubs. Knowledge is a network formed around key concepts. There is no unique center, only numerous “outlets”.	(1) It has the characteristics of hierarchical structure. The result of cognition is the knowledge that forms hierarchical structure, which is highly structured and arranged according to the level of generalization. (2) Knowledge construction should be transformed from easy to difficult, from basic concepts and basic skills to comprehensive knowledge and advanced skills.

3. The Significance of Constructivism to Cartography

The early cartography took behaviorism as the guiding theory, took cartographers as the center, and lacked the analysis of users’ cognitive characteristics. Map users can only passively accept the design ideas, functions and information of the map. With the development of cartography theory and the progress of science and technology, the user oriented map design concept is widely recognized, and the map service concept is gradually integrated into the map design and production.

In the early 1990s, cartographers began to pay attention to the progress of cognitive science, and the application of cognitive laws in cartography has been paid more and more attention. Academician Gao Jun and other scholars proposed to introduce cognitive science into cartography, and explained the concepts of mental map and cognitive mapping in the article spatial cognition and cognitive cartography of maps; Academician Wang Jiayao believes that map spatial cognition is to realize the cognition of geospatial environment by using cartographic methods [4].

It is a common cognitive activity for users to obtain geospatial information. In the process of understanding the external world, through assimilation and adaptation, the cognitive structure is constantly developing from low level to high level [5]. The

variability of cognitive structure and the nature of the development from low level to high level show that once the map carrying all kinds of geospatial information is received by map readers in the visual environment, it will inevitably lead to the change of readers' cognitive structure. This kind of change caused by assimilation and adaptation is a process of information processing, and map users correspondingly increase the knowledge related to maps. The psychological process of reading maps makes the achievement of spatial cognition logically inevitable.

To sum up, reading and using maps is undoubtedly a process of building geospatial knowledge for map users. The processing of geospatial information based on the original experience is highly consistent with the view of constructivism. Therefore, in-depth study of geospatial cognition based on constructivism theory will inevitably promote the research progress of cartography theory, which has guiding significance for map design and practice.

4. Map Information Transmission and Geospatial Cognition Based on Constructivism

4.1. Map Information Transmission Process Based on Constructivism

The theory of map information transmission mainly studies the process and method of map information transmission, which is the link between map drawing and map use. The map information transmission model proposed by Czechoslovakia cartographer klasny directly reveals the process of geospatial information transmission. This paper reinterprets the map information transmission process based on constructivism theory from the perspective of constructivism, as shown in figure 1. According to the traditional view, information is stable, objective and reliable, and the process of drawing is the reproduction of thinking to the content and structure of the objective world; Based on the view of constructivism, geospatial information is the subjective creation of geospatial information provided by map users in the background of their original knowledge and experience, not just the reflection of the objective geospatial environment.

4.2. Map Cognitive Process Based on Constructivism

Map cognitive theory is an important branch of cognitive theory and one of the basic theories of cartography. It mainly studies the process of people's spatial perception and spatial thinking information processing, that is, how people understand the relevant position, spatial distribution, dependence of the environment and various things and phenomena in it, as well as their changes and laws [6].

The main characteristics of the ideal cognitive environment advocated by constructivism are "situation, cooperation, communication and knowledge meaning construction". At present, with the rapid development of computer simulation technology and cartography technology, it is completely possible to build a map environment in line with constructivism. It can stimulate the curiosity of map users, inspire them to think actively and complete the construction of geospatial knowledge. Based on the traditional map cognitive process model, this paper describes the map

cognitive process based on constructivism, as shown in figure 2. The core cognitive object is still maps. Supported by emerging technologies, map spatial cognitive environment with the function of “cooperation and communication” is created to stimulate the “motivation” and “attention” of map users, so as to reduce the difficulty of geospatial cognitive process for general map users, and promote the mastery of spatial knowledge and the construction of spatial concepts.

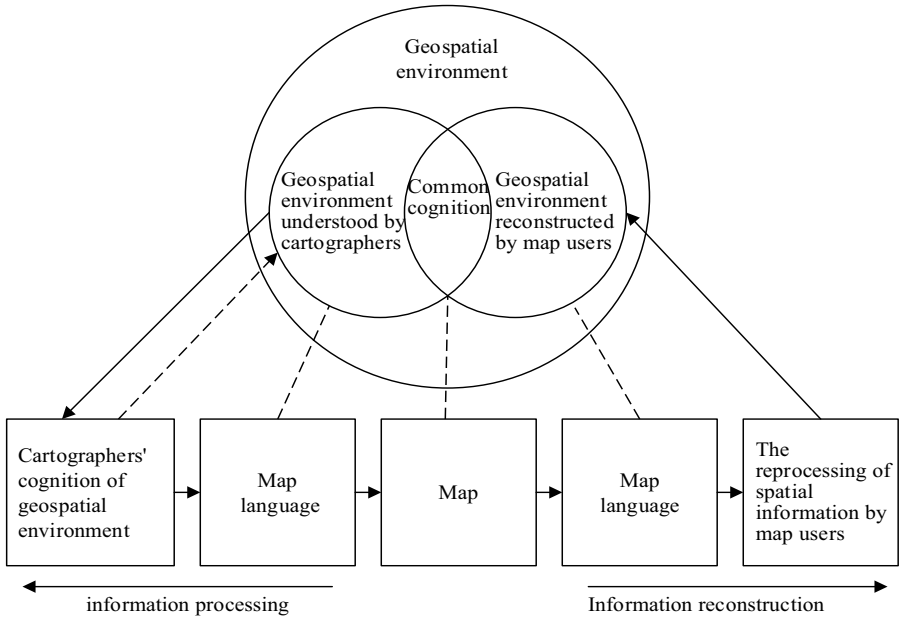


Figure 1. Map information transmission process based on Constructivism.

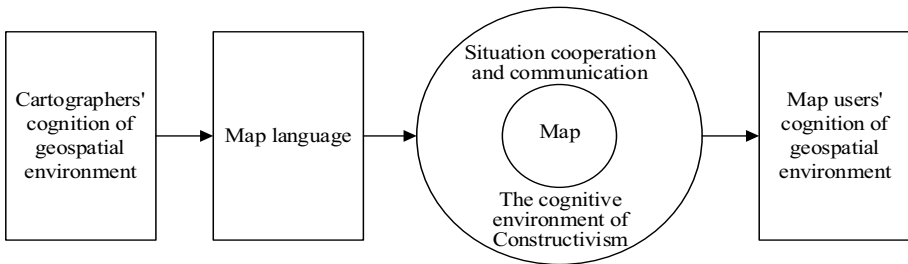


Figure 2. Map cognitive process based on Constructivism.

5. Map Service Model from the Perspective of Constructivism

Academician Wang Jiayao pointed out that the future development direction of cartography is to take the integration of geospatial information acquisition, processing and service as a system, and to provide geospatial comprehensive services as the ultimate goal [7-9]. The development of computer network technology, 3S technology, virtualization technology, network and grid service technology makes geospatial integrated service possible. To achieve this change, we must take advanced ideas as

support [10-13]. Undoubtedly, constructivist cognitive theory is highly consistent with the concept of “knowledge building” oriented to learners and the concept of map service in the era of Internet plus space-time big data. Based on this, this paper proposes a map service function model based on Constructivism according to the four elements of “situation, cooperation, communication and meaning construction” advocated by constructivism cognitive theory, as shown in figure 3. The feature of the model is to divide the existing map service functions into scenario building module and collaboration and communication module under the guidance of constructivism theory [14-15]. Using the basic functions, auxiliary functions and virtual geographic environment construction technology of map to construct a “Scene” which is beneficial for map users to recognize geospatial environment knowledge; Using the map interaction function and social platform interaction to build a “cooperation and communication” environment, the user can complete the construction of geospatial environment cognition in the cooperation and communication environment.

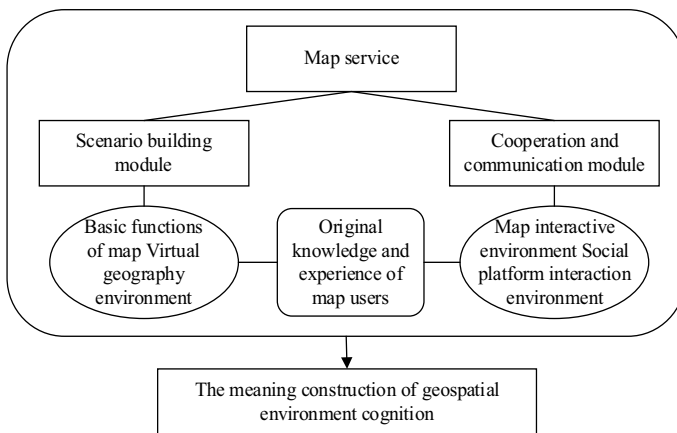


Figure 3. Map service model based on Constructivism.

6. Conclusion

The progress of cognitive science research has brought revolution to the development of map theory and practice. Based on the in-depth analysis of the basic theoretical viewpoints, this paper explains the map information transmission and geospatial environment cognition based on constructivism theory, and constructs the geographic information transmission process model and map cognition process model; According to the four elements of "situation, cooperation, communication and meaning construction" advocated by Constructivist cognitive theory, a map service model is designed. Technology advances in development and theory improves in development. There are still many problems to be discussed and studied in cartography theory and technology based on constructivism.

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