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RESEARCH ARTICLE

Construction and Analysis of the Index of the Construction Capacity of Civic Science Literacy in China

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ABSTRACT

The Construction of Chinese Civic Scientific Literacy (CCSL) was the outcome of the promotion and implementation of the Outline of National Scientific Literacy. It was significant to evaluate the development of CCSL in each area. In this paper, relevant statistical data of civic scientific literacy were abstracted from the Statistics of Science and Technology Popularization in China to construct the Index of the Construction of Chinese Civic Scientific Literacy (ICCCSL). Through the measurement analysis of the ICCCSL, the status of CCSL in each area was clearly reflected and a theoretical guideline was provided for the fair development of CCSL.

Keywords: Science Popularization; Construction of Civic Scientific Literacy, Index of Construction of Chinese Civic Scientific Literacy, Media Indicators

Introduction

In modern society, the relationship between science and technology (S&T) and economic and social development is increasingly getting closer. 'The influence of S&T has extended to every aspect of human life. S&T is more related to social and environmental issues. S&T has been the core for the survival and development of individuals' (Zhai, 2009). Learning, mastering and application of knowledge, information and methods of S&T are important prerequisites for citizens to make use of and share the scientific fruits, thus maintaining their survival and pushing development.

Scientifically literate citizens are more likely to comprehend S&T information better and thus pursue their civil rights, which is a strategic requirement for the improvement of comprehensive national power and economic and social development. Improving the civic scientific literacy level is becoming an important part of science education and life-long education, especially, the basic education system in various countries of the world (Zeng and Liu, 2008).

Science Popularization (SP), Business of SP and CCSL in China

The rapid development of S&T has deeply influenced economic and social development and progress of the human civilization. People today are more aware about S&T issues and there is more interdependence and interaction between S&T and society. As a bridge between science and public, SP has introduced knowledge on natural science and social science, promoted the application of S&T, spread the scientific concept and advocated the scientific spirit through various media channels to the public in a simple, acceptable, and easily understandable manner. In China, SP aims at improving the scientific literacy of all the Chinese people.

The Chinese government, in recent decades has attached great importance to SP. It is an important work carried out by governments, social organizations and other relevant departments with specific targets and at different scales.

The Ministry of Culture, People's Republic of China established the Bureau of S&T popularization to take charge of SP in the country. Later, special SP institutes were set up in various departments of the central and local governments. Government also constructed a number of national-level science museums. Special funds for SP were provided by the central government and local governments (MST, 2008).

In the 21st century, the central government issued the *Law on Science and Technology Popularization of the People's Republic of China* (2003) and *the Outline of the National Scheme for Scientific Literacy* (2006-2010-2020). The Office of the Implementation of Outline of Scientific Literacy for All Citizens

was also set up to coordinate 33 member units in the implementation of the outline. It organized and assigned tasks of SP to all levels of governments (CAST, 2008).

The *Outline* was a big system for the improvement of scientific literacy of all citizens. It contained a series of actions and projects. Four actions were worked on: *Minors' scientific literacy action, Farmers' scientific literacy action, Urban workforce scientific literacy action,* and *Leading cadres and public servant's scientific literacy action.* Four infrastructure projects of SP were designed: *Science education and training project, Development and sharing project of resources of SP, capacity building of SP of mass media,* and infrastructure *of SP*.

In the period of the '12th Five-year Plan', (2011-2015) the slogan of SP in China was 'innovation in succession and development in innovation'. New requirements were proposed in the implementation of the *Outline of the National Scheme for Scientific Literacy* (2011-2015). A new action (community residents) and a new infrastructure project (SP talent project) were added for the purpose of expanding the coverage of benefit for people's livelihood and strengthening the capacity of CCSL in China.

There had been a transformation from traditional S&T popularization to citizens' scientific literacy construction (Zheng and Gao, 2008). CCSL mainly included a comprehensive SP system for the public with basic science literacy. Through effective integration of knowledge, information, human, financial and material resources, this system refined and redistributed S&T knowledge and information from scientific communities, and popularized knowledge of S&T, basic methods of science, science thoughts and ethos to the public via the SP workers and the mass media. The whole system of SP was composed of a series of basic elements, like SP background, target, organizer, object, content, carrier and effect. A combination of these elements achieved the complete process of S&T information generation and communication.

Therefore, it was significant to evaluate the status and find out the patterns and features of CCSL in each area in China in a reasonable and accurate way.

The Construction of ICCCSL

After the implementation of the *Law of the People's Republic of China on Popularization of S&T*, in order to monitor the business of SP in China, SP statistics had been launched as an important part of Chinese S&T statistics since 2005. The data collection covered 24 departments of central, provincial, local and county levels governments, and included 32 provincial units. It was the official data that could reflect the actual status of the construction of civic scientific literacy in each provincial unit.

Generally, a comprehensive index should be constructed in order to evaluate the status of the construction of civic scientific literacy. According to the SMART (Specific, Measurable, Achievable, Realistic and Timed) indicator design principle, five basic structural factors of the construction of civic scientific literacy were chosen: SP personnel, SP infrastructure, SP expenditure, SP media, science education and training. These basic structural factors were able to reflect the status of the construction of civic scientific literacy under the informal education frame in China. Indicators and data of each basic structural factor were provided by SP statistics, sub-index and its weights were selected and defined via Delphi method (Table 1). The Index of the Construction of Chinese Civic Scientific Literacy (ICCCSL) could thus be constructed (Ren, 2011).

Table 1 — The Index of the Construction of Chinese Civic scientific literacy (ICCCSL)

SP personnel	1. Full-time SP staff
	2. Full-time staff at least intermediate certificated, or college degree and above
	3. Full-time rural SP staff
	4. Full-time SP writing staff
	5. Part-time SP staff
	6. Part-time staff at least intermediate certificated, bachelor degree or above
	7. Registered SP volunteers
	8. Working hours of part-time SP staff

SP infrastructure	1. Science museum
	2. S&T museum
	3. S&T museum or station of teenager
	4. SP (S&T) activity room of the urban community
	5. SP (S&T) activity venue of the rural
	6. SP propaganda car
	7. SP galleries
SP expenditure	1. The ratio of annually regional SP expenditure to GDP
	2. SP special funds
	3. Funds of S&T activity week
	4. The use of annual SP expenditure
SP media	1. SP book
	2. SP periodical
	3. SP (S&T) audio-video product
	4. S&T newspaper
	5. SP (S&T) program of television station
	6. SP (S&T) program of radio station
	7. SP website
	8. SP readings and materials
Science education and training	1. SP (S&T) lecture
	2. SP (S&T) exhibition
	3. SP (S&T) contest
	4. Teenager S&T interest Groups
	5. S&T Summer (Winter) Camps
	6. S&T activity week
	7. Universities, research institutions opening
	8. Organizing practical technology training
	9. Important SP activity

Considering the regional differences of territory and population between regions in the country, per capita was used to eliminate these differences of indicators. Due to the different dimensions of indicators, data of indicators were standardized to compute each of the sub-index. Specifically, the extreme linear normalization method was adopted for the standardization of the

indicators by keeping the same relative position of each indicator, with which one could compare different sub-index in the same scoring interval. The formula for extreme linear normalization is as follows:

$$\chi_i' = \frac{\lambda_i - \lambda_{\min}}{\chi_{\max} - \chi_{\min}}$$

χ_i' is the standardized value, χ_i is the statistic value, $\chi_{\max}$ is the maximum value of the indicator and $\chi_{\min}$ is the minimum value of the indicator. The scoring interval of each indicator is [0, 100]. 0 represents the minimum value of the indicator and 100 represents the maximum value of the indicator.

Data processing led to construction of 5 sub-indexes, including SP personnel indicator, SP infrastructure indicator, SP expenditure indicator, SP media indicator and science education and training indicator, and then summed up these five indicators with equal weights. In this manner the ICCCSL was obtained.

Analysis of the Development of CCSL

Standardized data to build ICCCSL and its sub-indexes not only reflect the development of scientific literacy construction and various factors which could be used to analyse the comparative status of provinces. Additionally, every specific indicator also reflected the reality of various regions. For comparative analysis we constructed bar charts of ICCCSL and the sub-index of each province. In addition, we drew radar charts based on specific indicators of each factor and sub-indexes of ICCCSL for every province. The inadequacy of each factor of ICCCSL could be gauged from the radar charts of each province. Through the bar and radar charts based on ICCCSL and its sub-indexes, we conducted the comparative analysis among provinces and feature analysis for every province. The following contents were the detailed analysis of the application of ICCCSL.

Comparative analysis of ICCCSL

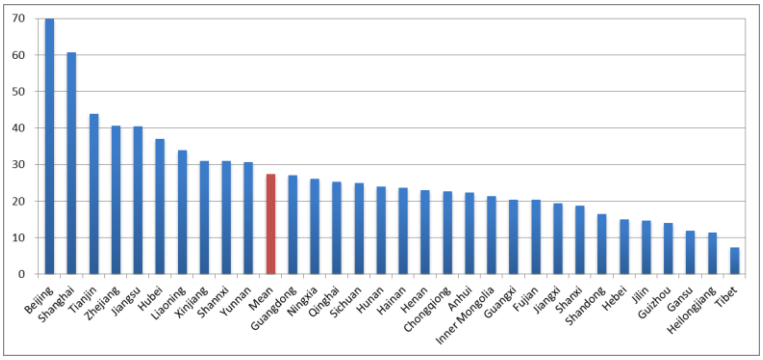
We calculated ICCCSL via averaging SP personnel index, SP infrastructure index, SP expenditure index, SP media index and

science education and training index with equal weights to evaluate the development of CCSL of each province, and then drew the bar chart of the ICCCSL of each province, as shown in Figure 1.

As can be seen from Figure 1, there is an imbalance in the development of ICCCSL among the provinces. For example, Beijing and Shanghai were much better than the other provinces, but Tianjin, Jiangsu, Zhejiang achieved a more leading position, and Hubei, Liaoning, Shanxi, Xinjiang and Yunnan exceeded the average level of the nation. Although Guangdong, Sichuan, Hunan, Henan and Ningxia were slightly lower than the national average level, they were still in the middle position. Anhui, Inner Mongolia, Qinghai, Chongqing, Guangxi, Fujian, Jiangxi, Shanxi, Hainan and Shandong were in the lower position, and Hebei, Jilin, Gansu, Guizhou, Heilongjiang and Tibet were at the lowest level of the national comparative scale.

The highest ICCCSL scores of Beijing and Shanghai crossed 55, compared to the lowest scores of Guizhou, Heilongjiang and Tibet just about 10. We also found that the ICCCSL of each province did not correspond exactly to its economic and social development status. Hubei of central region and Shanxi, Xinjiang, Yunnan of western region scored better positions than their economic and social development would indicate. However, Shandong, Hebei of eastern region and Jilin, Heilongjiang of central region got a lower position than their economic and social development level.

Figure 1 — Bar chart of each province ICCSL



The imbalance in the development of CCSL among provinces revealed by ICCCSL provided a good reference to eliminate the regional disparities.

Comparative analysis of ICCCSL factors

The analysis of ICCCSL factors revealed a similar picture. Taking the SP expenditure index of ICCCSL as an example, it contained indicators of annual total SP budget of each province, the ratio of the special SP budget and GDP of each province, S&T week expenditure and annual SP expenditure. The bar chart of SP expenditure index of ICCCSL of each province is shown in Figure 2.

Figure 2 shows that Shanghai and Beijing at the highest SP expenditure levels, with the other provinces far behind. The national average score was just 25, but Hebei, Henan, Jilin, Heilongjiang, and Shandong did not get good scores. So, the development of SP expenditure showed extremely uneven situations among provinces in China.

Feature analysis of ICCCSL

The radar charts of ICCCSL and its sub-indexes in each province showed all selected indicators in one chart. Thus, it was easy to find the inadequacy in each chart. Taking a province of the central region as an example, a radar chart is shown in Figure 3.

Figure 2 — Bar chart of each province's SP expenditure index of ICCSL

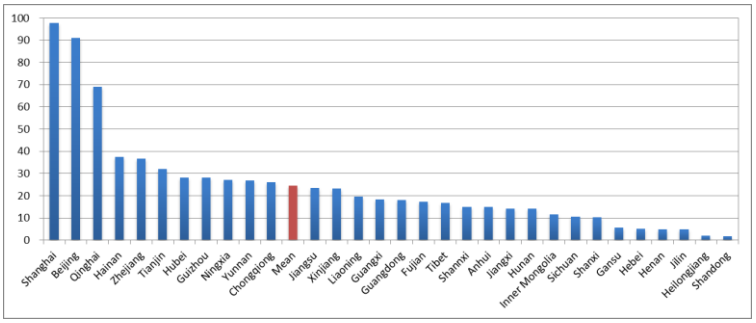
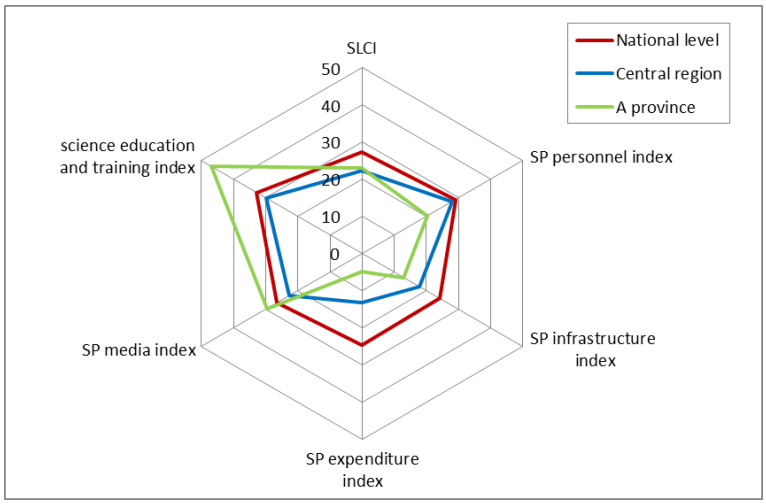


Figure 3 — Radar chart of ICCSL and sub-index of a province



Although the scores of ICCCSL in a province got close to the central region and the national average level, the scores of science education and training in a province were much higher than the central region and the national average level; the scores of SP media were a little higher than the central region and the national average level. The scores of SP personnel and SP infrastructure were lower than the central region and the national average level, and the scores of SP expenditure were much lower than the central region and the national average level. Thus, the level of development of scientific literacy construction in a province could be clearly revealed. This analysis can provide a reference for promoting balanced development in each province.

Conclusions

It could be concluded that ICCCSL based on the data of SP statistics could evaluate the capacity of CCSL among provinces and reveal the imbalances among SP personnel index, SP infrastructure index, SP expenditure index, SP media index and science education and training index in each province. The balanced distribution of CCSL resources is an important prerequisite to improve the scientific literacy of all citizens.

It was the first time that these quantitative comparative analyses and feature analyses clearly reflected the features and shortages of the development of CCSL in each province. Hence, it would be useful to build a method to analyse ICCCSL so that governments can make effective measures to allocate resources more fairly.

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