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RESEARCH ARTICLE

Civic Scientific Literacy Survey in China

HE WEI, REN LEI & ZHANG CHAO

Division of Scientific Literacy Research,
China Research Institute for Science Popularization,
86 Xueyuan Nanlu, Haidian District, Beijing, 100081 China

E-mail: dupolin@sina.com

ABSTRACT

Chinese civic scientific literacy survey has been conducted for over 20 years. The findings of Chinese civic scientific literacy have directly promoted the implementation of *The Law of the People's Republic of China on Popularization of Science and Technology* (2003) and *Outline of the National Scheme for Scientific Literacy* (2006-2010-2020), and provided important support for the development of the business of Science Popularization (SP). The history of Chinese civic scientific literacy survey, modification and improvement of index system and questionnaire design, the trend analysis of Chinese civic scientific literacy and attitudes toward S&T are introduced in this paper, which would be helpful to fully understand SP monitoring and evaluation work in China.

Keywords: Scientific Literacy, Chinese Civic Scientific Literacy Survey

As one of the world's few countries regularly carrying out Scientific Literacy Survey, China had launched a series of national civic scientific surveys since 1992, which were conducted in 1992, 1994, 1996, 2001, 2003, 2005, 2007, 2010 and 2013. The survey conducted in 2013 was different from the earlier surveys in the sense that sample was collected from 12 provinces out of total 32 provinces of China. Previous survey results were published as a chapter in the national yellow book named *Chinese Science and Technology Indicators*, and Chinese survey results were also adopted in NSF *Scientific Engineering Indicators* — '*Chapter VII: Science and Technology: Attitudes and Understanding*'.

The results of previous Civic Scientific Literacy Surveys widely attracted attention of scholars and research institutions and also provided important data reference for policy-making. Civic scientific literacy as a basic indicator was adopted by *The Law of the People's Republic of China on Popularization of Science and Technology* (2003) and *Outline of the National Scheme for Scientific Literacy* (2006-2010-2020). In addition, the developmental goal of Chinese Scientific Literacy has been an integral part of national innovation document.

Over the years data analysis was extended from simple frequency analysis to explore the complex relationship between civic scientific literacy and economic and social aspects of the respondents. After several rounds of modification of index system and questionnaire of Civic Scientific Literacy Survey, it became a comprehensive and adaptable survey system that could reflect the actual situations in China. The surveys so administered allowed international comparison under specific contexts. The development of Civic Scientific Literacy Survey in China was introduced as follows:

History of Civic Scientific Literacy Survey in China

The Civic Scientific Literacy Survey in China was conceived as a major project to monitor and evaluate civic scientific literacy. It contained three broader parts: Interest, Information Sources and Involvement of S&T that included public understanding of science and public attitudes about S&T among Chinese citizens (18 to 69 years old). The findings of the Survey can provide basic data for monitoring and evaluation of *Outline of the National Scheme for Scientific Literacy* and preparation of related policies. As a continuous and national sampling survey, nine Chinese Civic Scientific Literacy Surveys have been carried out from 1992 to 2013. All aspects of the survey processes such as preparation, implementation, quality control, evaluation and analysis matured during the past twenty years (Table 1).

Table 1 — Technical Parameters of all Previous Civic Scientific Literacy Surveys in China

Survey Year	1992	1994	1996	2001	2003	2005	2007	2010	2013
Sample Size	5500	5000	6000	8520	8520	8570	10080	69360	26700
Sample Method	PPS		Stratified 4-stage PPS with unequal probabilites			Stratified 3-stage PPS with unequal probabilites			
Reference	The fourth national census of China		Household Register		The fifth national census of China & 1% Population Sample Survey			The sixth national census of China	
Weighted	Gender		Age, Education, Gender, Rural/Urban population						
Scope	32 provincial units								
Survey Method	Face-to-face interviews								
Target	Citizens of 18-69 year								
Agency	Ministry of Science and Technology of the People's Republic of China (MOST) and China Association of Science and Technology (CAST)						China Research Institute for Science Popularization (CRISP)		
Approved	National Bureau of Statistics of China								

Reviewing the two decades of Chinese Civic Scientific Literacy Survey, it could be categorized into three stages: the first stage was from 1992 to 2000, which was the establishment and exploration period for the survey. Three surveys were carried out in 1992, 1994 and 1996, which were conducted by former State Scientific and Technological Commission and Chinese Association of Science and Technology (CAST) with approval of National Bureau of Statistics. Simple PPS was used and a total of 5000-6000 filled-in questionnaires were collected. The databases were created out of the collected questionnaires and the databases were weighted by gender in these three surveys.

The second stage was from 2001 to 2005, which was the development and localization period for Civic Scientific Literacy Survey. Business of science popularization had assumed national importance since 2000; national science popularization network and research support had been established by CAST. Index

system and questionnaire content had been adapted and developed to reflect reality in China. Three national surveys were carried out in 2001, 2003 and 2005. Unlike the previous surveys, these surveys were conducted and implemented by Chinese Research Institute for Science Popularization (CRISP) and four-stage stratified probability ranging PPS method was adopted. During each survey more than 8000 respondents were interviewed and the database was weighted by gender, age, education level and urban-rural variables.

The third stage began in 2006, it could be designated as 'mature period of the survey', which culminated into refined survey conducted in 2013. Continuous survey was integrated in national statistical system. Three national surveys were carried out during this period (in 2007, 2010 and 2013). With the issuance and implementation of *Outline of the National Scheme for Scientific Literacy* in 2006, it was required that civic scientific literacy should be monitored and evaluated regularly. The surveys conducted during the third phase were approved by the National Bureau of Statistics and also by the national statistical sequence of departments. Moreover, considering huge regional disparities in China, sample size of the survey was expanded in order to evaluate civic scientific literacy level for each province in China. The sampling design of survey 2010 was divided into 32 provincial units sampling frames, so that it could get the results of each province. This form of sampling design became a new evaluation idea in China, which incorporated the public scientific literacy evaluation in different regions *vis-a-vis* the whole country. After implementation of *Outline of the National Scheme for Scientific Literacy*, Civic Scientific Literacy Surveys for local citizens were carried out in some provinces of the country with a smaller sample size.

Evolution of Chinese Civic Scientific Literacy Index System

Based on over two decades' practice of Chinese civic scientific literacy surveys, many experiences had been accumulated for improvements of different aspects of National survey operations, such as modification of index system, questionnaire design, sampling design, calculation method of scientific literacy, etc.

Evolution of Index System and Questionnaire Design

Index system and questionnaire design constitute the core of any survey. Literature review of similar surveys, administered in other countries provided the references, which enabled the Chinese research team to establish the following three sub-indexes of the questionnaire:

a. Interest, information sources and involvement of S&T

b. Public understanding of science

c. Public attitudes toward S&T

The structure of the indicators in the questionnaire were kept the same as in previous surveys, with some modifications to adapt the social relevance. Public involvement in science popularization activities and infrastructure facilities have been added since survey 2003; Internet in S&T as an information source had been added since survey 2003 (CAST, 2003); the variables of selected population have been added since survey 2007 (He *et al*., 2008), public science and technology issues have been added since survey 2013, trust of S&T information sources have been removed since 2010 (Ren, 2011). Given below is the latest index system of Chinese Civic Scientific Literacy of Survey conducted in 2013 (Table 2).

Table 2 — Index system of Chinese Civic Scientific Literacy Survey 2013

Sub-index	Level 2 indicator	Level 3 indicator
Public understanding of science	Basic scientific knowledge	(1) Understanding of scientific terminology
		(2) Understanding of scientific concepts
	Basic scientific methods	(3) Understanding of science inquiry
		(4) Understanding of 'comparison test'
		(5) Understanding of probability
	Influence of science on individuals and society	(6) Judgement of Pseudo-Science
		(7) Influence of science on individual behaviors
	Understanding of public S&T issues	(8) Understanding of climate change

		(9) Understanding of nuclear power
		(10) Understanding of GM food
Interest, information sources and involvement of S&T	Information sources of public S&T issues	(11) Paper media
		(12) Film and television media
		(13) Sound media
		(14) Network
	S&T Channels	(15) Paper media
		(16) Film and television media
		(17) Sound media
		(18) Network
		(19) Interpersonal communication
	SP activities	(20) Special popularization activities
		(21) Daily popularization activities
	SP facilities	(22) Science and technology venue
		(23) Humanity and art venue
		(24) Popularization place
		(25) Professional science and technology place
	Participation in public S&T affairs	(26) Personal concern
		(27) Discussion with friends and relatives
		(28) Enthusiastically take part in
		(29) Actively take part in
Public attitudes toward S&T	Interest in S&T development	(30) Interest in scientific and technological news
	Attitude towards science and technology	(31) Science, technology and life
		(32) Science, technology and work
		(33) Understanding of science and technology
	Attitude towards public S&T issues	(34) Trust in information source of public scientific and technological issues

		(35) Understanding and opinion on climate change
		(36) Understanding and opinion on nuclear power
		(37) Understanding and opinion of GM food

Initial lessons for questionnaire development were taken from *Public Attitudes Toward and Understanding of Science and Technology Survey of United States* hosted by the famous American scholar, Jon D Miller (Miller, 1983) who developed the scale of factual scientific knowledge and this scale has been applied in many countries to measure civic scientific literacy. The surveys conducted in 1992, 1994, 1996 and 2001 kept almost all the indicators used in United States. Later, the index frame and contents of questionnaire used for Chinese Civic Scientific Literacy Survey have been modified and redesigned since 2003.

Firstly, the scale of local scientific knowledge had been developed, which was extended to include specific items based on Chinese context; secondly, five common pseudo-science phenomena (Chinese fortune sticks, physiognomy, horoscopes, Duke dream and fortune-telling through computer) have been added into the questionnaire to evaluate respondents' opinion on pseudo-science and thirdly, individual's awareness and participation in scientific popularization activities (Science and Technology Week, Science Festival, Scientific Popularization Day, Science and Technology Consulting, Technology Training, Scientific Popularization Lecture and Science and Technology Exhibition) have been added in the questionnaire. Finally, three public S&T issues have been added into the survey 2013 to get public attitudes on climate change, nuclear power and genetically modified food.

Evolution of Sampling Design

In order to gather a nationwide representative sample, a complex sampling method had been developed. Probability-Proportional-to-Size Sampling (PPS) method had been used in the first three surveys of 1992, 1994 and 1996. Advanced sampling method of multi-stage stratified sampling with PPS which replaced

Probability-Proportional-to-Size Sampling was implemented after survey 2001 (Yongjin and Yan, 2008). The entire sampling frame was stratified by urban layer and rural layer, and further stratified to lower strata. The improvement of this sampling method was more affective taking into account the huge difference between urban and rural areas.

It is worth mentioning that, considering the needs of Civic Scientific Literacy evaluation by local government, the sampling design of Civic Scientific Literacy Surveys had been modified from nation-wide sampling frame into province-wide sampling frame during the 2010 survey. The Chinese Civic Scientific Literacy was computed by integration of all provinces. The added advantage of this new sampling design was that it generated databases for both national and provincial civic scientific literacy.

The databases were weighted by single gender variable for the first three surveys conducted in 1992, 1994 and 1996 and after 2001 survey, PPS weighted method was adopted to fix demographic variables distribution (Yongjin and Fei, 2002).

The Measurement of Civic Scientific Literacy in China

Before the 2010 survey, the level of Chinese civic scientific literacy was measured based on three aspects; a) knowing the necessary scientific knowledge; b) mastering basic scientific methods; and c) advocating the ethos of science. The respondents who passed all the thresholds (Ren, 2010) of these three aspects of tests were to be regarded as scientifically literate. The proportion of Chinese citizens with scientific literacy was shown as the result of this survey (Ren, 2010).

The measurement of civic scientific literacy was modified for the 2013 survey. Compared to the previous measurement of civic scientific literacy, Item Response Theory (IRT) technology was adopted to sum up an individual independent's score among all three aspects mentioned above which was widely used. In terms of individual scores on civic scientific literacy, the resulting scores range from approximately zero to 100. Because the evaluation of scientific literacy was essentially capacity assessment, IRT was a more accurate method to evaluate civic

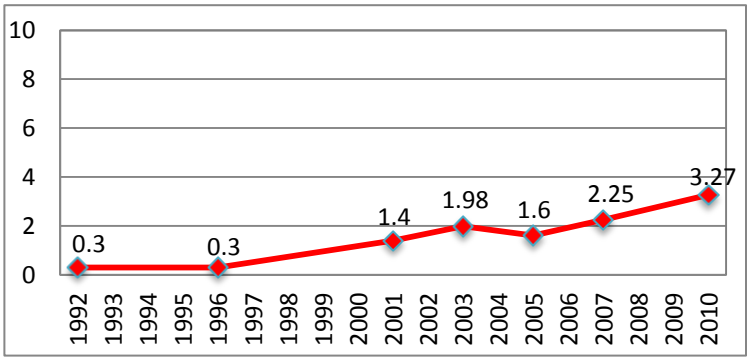
scientific literacy. A score of 70 was the threshold measure of civic scientific literacy that was on account of international comparison (Bauer *et al*., 2012).

Trend Analysis on Chinese Civic Scientific Literacy

The Chinese Civic Scientific Literacy Survey has collected longitudinal data for over 20 years, which was useful for the longitudinal analysis of the development of Chinese Civic Scientific Literacy, public interests and attitudes toward science and technology and access to S&T information. Longitudinal analysis did not include the 2013 survey, as during the 2013 survey data was collected only from 12 provinces and it did not match with the previous data sets.

It could be seen from Figure 1 that the level of civic scientific literacy in China had improved gradually since 1992. This trend showed that with the development of economy and society, probably the most relevant reason is the government and society paid more attention and made more investments in education, and the education level of citizens was gradually improved (UNDP, 2014). Although the proportion of Chinese civic scientific literacy was 3.27% in 2010, based on this trend we believe that Chinese civic scientific literacy would keep on increasing if the funds into the education sector are invested at the same pace and continuous attention could be paid by the government.

Figure 1 — Trend of Chinese Civic Scientific Literacy



As China's education and basic population quality had made great progress over decades, we observe that the level of scientific literacy of the younger generation was significantly higher than that of other age groups. Moreover, with the passage of time, the scientific literacy levels of the new generation of young people were higher than the young generation ten years ago (as the blue line shows in Figure 2, detailed data after 2001), which reflects the success of Chinese government policies and society's commitment to continuous investment in education in recent years.

Another important objective of the longitudinal analysis of civic scientific literacy development was to probe the difference between urban and rural areas. It can be seen from Figure 3 (detailed data after 2001) that the scientific literacy level of both urban and rural population in China had significantly improved over the past 10 years. However, the growth rate of scientific literacy level of urban residents was higher than that of rural residents.

Three items of interest in S&T information, namely, 'new scientific discoveries', 'new inventions and new technologies' and 'new medical progress' were kept in all surveys, which was used to carry out comparative analysis. The trend analysis did not include the analysis for 2001 and 2010 survey due to different response option settings in survey 2001 and 2010. It can be seen from Figure 4 that the trend of these three items on

Figure 2 — Trend of Chinese Civic Scientific Literacy of age groups

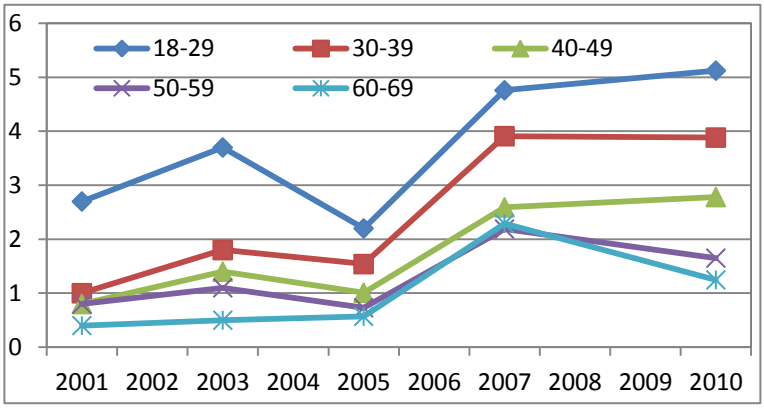
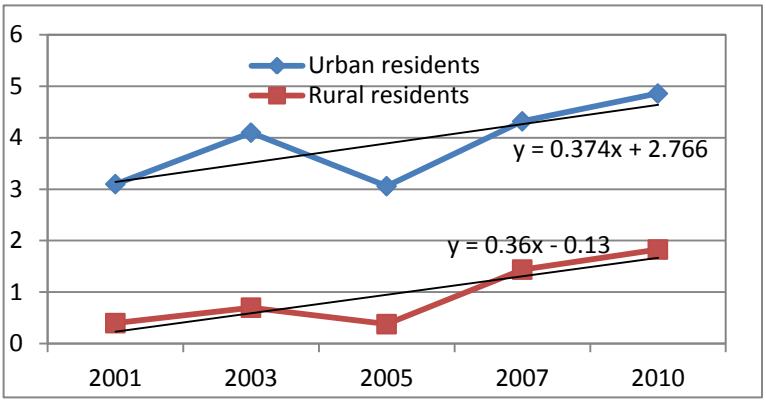


Figure 3 — Trend of Scientific Literacy of Chinese Urban and Rural Residents



the interest in S&T development information was almost constant. Taking the year of 2000 as a cut-off point, public interests in scientific and technological development information showed a significant growth.

From the perspective of these three items, Chinese citizens were most interested in 'new scientific discoveries' in the past 15 years. During recent times citizens have become more interested in scientific and technological information and their interest in 'new medical progress' gradually increased compared to 'new inventions and new technologies', which is shown in Figure 4.

'Science and technology make our lives healthier, easier and more comfortable' was posed to the respondents for every survey. The index for the question remained almost same throughout except for 2003, where some modification was made in the questionnaire (Figure 5). It can be seen from Figure 5 that positive impacts of science and technology, designated as 'b', 'c', and 'd' have shown very stable trend as in the last decade. Analysis also revealed that public attitude towards the impact on S&T, such as 'Technological discoveries will eventually destroy the earth' also showed an upward trend.

Thinking and Expectation of Civic Scientific Literacy Survey in China

The survey on scientific literacy in the United States started in the middle of the last century. The surveys have tremendous

Figure 4 — Trend of Chinese Interests in S&T Development

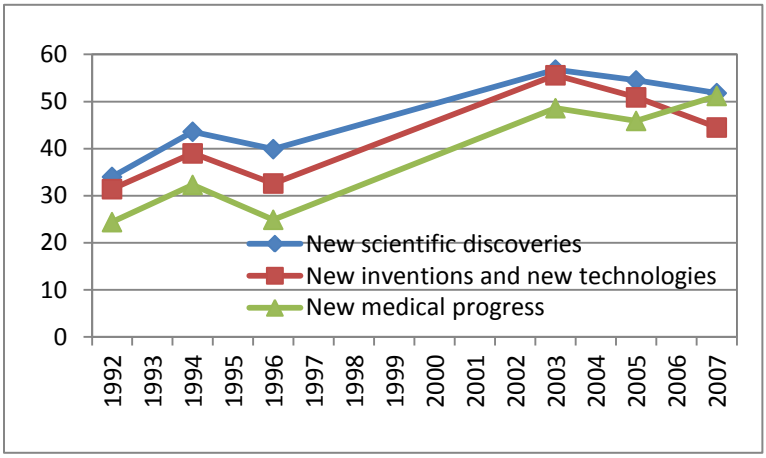
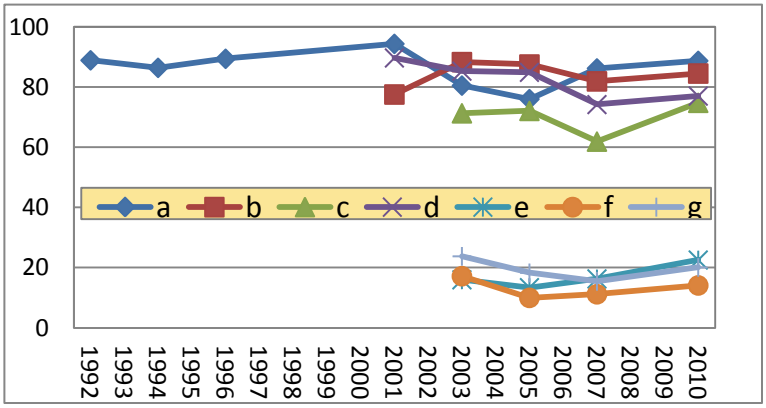


Figure 5 — Trend of Chinese Citizens' Attitudes toward Science and Technology



a	Science and technology make our lives healthier, easier and more comfortable.
b	Thanks to science and technology, there will be more opportunities for future generations.
c	The benefits of science are greater than any harmful effects it may have.
d	Even if it brings no immediate benefits, scientific research which adds to knowledge should be supported by Government.
e	Technological discoveries will eventually destroy the earth.
f	Even without S&T, people can live very well.

social impact in the world and have strong relationship between citizens, technology and society. Ever since the Chinese Civic Scientific Literacy Survey was first conducted in 1992, it has been gradually developing from initial departmental research into an important social evaluation index. After 2000, all sectors of the society recognized the important role of civic scientific literacy in economic development and social progress. National and regional civic scientific literacy survey has become a basic task for the government to evaluate the scientific literacy status and provide the necessary basis for decision making and relevant policy-making. The survey has formed a stable and continuous evaluation system since 2001.

Civic scientific literacy survey is basically a fundamental study of sociology. Many surveys include this aspect and the results have been collected into Science and Engineering Indicators of the National Science Foundation of U.S, such as the science module of US *General Social Survey* (GSS) (NORC, 2010) and *Europeans, Science and Technology Survey* (EC, 2005) have included this evaluation into their social monitoring and evaluation system as a part of long-term basic research. At present, China lacks such a comprehensive social monitoring and evaluation system. China is also putting its thought to expand the survey frame and plans to conduct themed and group-special surveys in order to get a better understanding of the public attitude towards S&T and related issues.

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