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RESEARCH ARTICLE

The 'Great Leap Forward' of Public Scientific Literacy in China*

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ABSTRACT

From 1992 to 2015 China investigated Chinese public scientific literacy and attitudes to S&T nine times. Originally, the framework of investigation of indicators was almost similar to investigations in *Science Indicators* initiated by Jon Miller in the 1970s. However, from 2005 to 2015 with more and more Chinese characteristics of related investigations, we find that the scientific literacy level of the Chinese public increased almost two times every five years. And the aim of the 13th five-year National Planning of Chinese public scientific literacy level has been set at 10% in 2020, which means the data will be double again in another five years in the future. According to the eighth investigation in 2010, 3.27% Chinese people have scientific literacy, which shows 14.67% people master scientific knowledge, 9.75% master scientific methods, and 64.94% worship the scientific spirit. How do we understand the last number which is so conflicted with the common sense of science sociology? Which side is lying: public, science, or investigation? This paper will talk about the problems in these investigations which are really unreasonable and even could be a big scandal if we compare with other countries' similar investigations and make an objective analysis of those data and results.

KEYWORDS: Scientific literacy; Great leap forward; National planning; China

Background: What Changed and What is Changing?

In 1582, Matteo Ricci (1552-1610), an Italian Catholic pastor came to China with the original motivation to bring God's grace

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to Chinese people. Later he found Chinese people were more interested in the practical knowledge of science and technology, so he wrote letters to the Catholic institution in Italy and asked the pastors to take more books of western science books to China.

In 1607, with the help of Guangqi Xu (1562-1633) who was both a high level officer and a traditional Chinese scholar in the Ming Dynasty (1368-1683), Matteo Ricci translated the first six chapters of Euclid of Alexandria's (Ευκλειδης) famous book *Elements* (Σηασεια) into Chinese. Matteo Ricci later on even became an officer in the Ming Dynasty and was called a 'western Confucian' in China. He was also the first western scholar who was especially permitted by the Chinese emperor to be buried in Beijing after his death — his grave is still in the downtown of Beijing.

As Matteo Ricci brought somewhat systematic knowledge (including some modern science books) to the Chinese intellectuals, in science history of China the year 1582 is admitted as the first time that the Chinese people began to recognize the western culture. Adam Schall, a friend of Galileo, mentioned in his book *Historical Narration of the Origin and Progress of the Mission to China* (Vienna, 1665) that he 'oversaw the publication of more than 30 scientific works in Chinese which drew upon Galileo, Copernicus, Tycho, Kepler and John Napier'.*

However, Matteo Ricci's academic influence was only in a very small circle of Chinese high-level intellectuals. The general Chinese people had to wait until 1905, the end of the Qing Dynasty (1636-1911) after a series of war failures between China and West, such as the First Opium War (1840), the Second Opium War (1860) and especially the war between China and Japan (who had been certainly been considered as students of Chinese culture in a long history) in 1895, when the Qing Dynasty at last cancelled its imperial examination which had been continued for about 1300 years in the history of China.

Since 1905, the Chinese people began to learn western knowledge/science in the general schools, and science and technology became the favorite majors for many young Chinese students to help China to be quickly stronger and richer. As a

* The book is exhibited in 'Galileo's world' in the Bizzell Memorial Library by the History of Science Collections, University of Oklahoma.

result, we can see until now ordinary Chinese public only had one hundred years to learn western knowledge of science and technology which belongs to a system of knowledge so different with traditional Chinese culture.

It is strange that the Chinese communist party paid very high attention to science popularization. In 1949, with the establishment of the People's Republic of China, the new government issued its temporary Constitution which had a special item (the 43rd) saying '(The government would) Encourage on science discovery, invention and science knowledge popularization'; this item was also kept in the Constitution of 1999. Some experts said 'the sciencism is one of Chinese government's ideologies', that science popularization belongs to a part of Chinese government's propaganda system and is controlled top down strictly.

The American expert, Bruce Lewenstein[1] once said in his summary of American science communication:

But, because of the local independence and initiative that characterize American life, no systematic attempt has ever been made to coordinate, or even catalogue, these activities. No national policy exists for public communication of science and technology (PCST), and neither does the base of information nor the political will to create such a policy exist.

Sharply compared with USA, science popularization* in China can certainly be viewed as government oriented. China's science popularization institution is mainly divided into three parts: First, CAST (China Association for Science and Technology, established in 1958) says it's the 'main strength of science popularization' in China according to the Law of Science Popularization which was enacted at 2002. Second, MOST (Ministry of Science and Technology, established in 1958) announces it's the 'leader of science of popularization' as MOST is a part of the National Council and the highest department of S&T management in China. Third, CAS (Chinese Academy of

* In China now, the government often uses 'science popularization' as an official term, and the academic community usually uses the term 'science communication'; however, they mean almost the same thing in China. In this report, I use both 'science popularization' and 'science communication' in different situations.

Sciences, established in 1949) mentions it's the 'national team of science popularization' as CAS historically played as the 'national team' during the research of atom bomb, strategic missile, hydrogen bomb, satellite and nuclear-powered submarine in the 1960s and 1970s, all of which were important indicators for new China's rising and getting back to United Nations in 1971.

Nowadays CAST and MOST compete in many areas of science popularization in China (CAS is relatively powerless with less funding in science popularization). CAST initiated the 'Project 2049' in 1999 (learned directly from 'Project 2061' of AAAS) and then the 'The National Action Plan of Scientific Literacy for All Chinese Citizens'; the MOST issued the 'Standard of Scientific Literacy'; CAST organizes the 'The National Science Popularization Day' every September; MOST mainly conducts the 'Science Week' every May (CAS also plays a big role in 'Opening Day' by opening its many famous national research labs in 'Science Week' too); CAST holds the 'Competition of Science Tutors' every two years, and MOST chairs the 'Popular Science Docent Competition'[2] every year, etc.

As CAST or MOST control some special areas of science popularization, other departments (such as Ministry of Education) of the government usually choose to cooperate, and this situation in fact may help to lead science popularization in China to narrower directions. However, on the other side, the competition between CAST and MOST also produces more space for different theories, ideas and policies of science popularization in China too. Under the perspectives of international comparison. I will talk about the topic of the 'great leap forward' of scientific literacy in China.

According to 'The Investigation Reports on Chinese civil Scientific Literacy', since 2001 to 2015 the percentage of Chinese people who have scientific literacy increased 4.4 times, from 2005 to 2015 almost every 5 years increased 2 times, and the national planning aim of 2020 will be double again of 2015. It is really unreasonable and impossible and even could be a big scandal if we compare with other countries' similar investigations and make an objective analysis of those data and results.

'Great Leap Forward' of scientific literacy in China[3]: Something wrong?

From 1992 to 2015, first the Ministry of Science & Technology (MOST) then the Chinese Association for Science & Technology (CAST) had supported nine times investigations of Chinese public scientific literacy (SL) and attitudes to S&T, the framework of investigation indicators are almost from similar investigations in *Science Indicators* initiated by Jon Miller in the 1970s.

The nine results of scientific literacy level of Chinese public according to nine related investigations are shown in Form 1. During the two decades from 1992 to 2015, the indicators, sponsors, and researchers of the nine investigations had changed. We can divide those investigations into three stages: 1992 to 1996 (using American questionnaire); 2001 to 2003 (keeping the main content of American questionnaire, but using some Chinese characteristic items such as using 'fortune telling' instead of 'astrology' as the latter one is a typical western concept and general Chinese public do not know it); 2005 to 2015 (the questionnaire is more and more Chinese characteristic and the investigations were supported completely by CAST).

From 2005 to 2015, we can see the scientific literacy level of Chinese public increased almost 2 times every 5 years. And the aim of the 13th five-year National Planning of Chinese public scientific literacy level has been set at 10%[4] just one year before, which means 5 years later the data will be double again. However, according to several investigation results in *Science and Engineering Indicators,* the increase of public scientific literacy is not only very hard, but also often pessimistic. For example, in *Science and Engineering Indicators 2006* the conclusion is: American people's scientific knowledge level remained 'unchanged' for about 15 years:

'Survey respondents' ability to answer most questions about science has remained essentially unchanged since the 1990s, with one exception: more people now know that antibiotics do not kill viruses. This may be attributable to media coverage of drug-resistant bacteria, an important public health issue.'[5]

Sharply in contrast, we can see in the similar 15 years (2005-2020) the Chinese public scientific literacy level will increase six times (10%/1.6%)! Some thing must be wrong.

Form 1 — Nine results of Chinese civil scientific literacy level from 1992 to 2015

Year	1992	1994	1996	2001	2003	2005	2007	2009-2010	2015
Percentage of SL %	0.3	0.2	0.3	1.4	1.98	1.60	2.25	3.27	6.20

Data resource : (1) The Chinese civil SL investigation project team, The Investigation Report on Chinese civil Scientific Literacy in 2001, Beijing: Publishing House of Science Popularization, 2002, P60; (2) The Chinese civil Scientific Literacy investigation project team, The Investigation Report on Chinese civil Scientific Literacy in 2003, Beijing: Publishing House of Science Popularization, 2004, P20; (3) He Wei, Zhang Chao, Ren Lei, The Investigation Report on Chinese civil Scientific Literacy (in 2009/2010), Beijing: Publishing House of Science Popularization, 2015, P9;（4）The result of the 9th Chinese civil Scientific Literacy investigation open, China Science Daily, 2015-09-21.

As there is no concrete data now about the newest investigation in 2015, we could also find big problems by analysing the result of the 2010 investigation of Chinese public scientific literacy in China. On 25 November 2015, CAST announced the results of the Eighth Investigation of Chinese Civil Scientific Literacy at a press conference which were as following:

In 2010, 3.27% Chinese people have basic scientific literacy, which shows 14.67% Chinese people master the scientific knowledge, 9.75% Chinese people master scientific methods, and 64.94% Chinese people worship the scientific spirit.[6]

According to sociology of science, to understand or 'worship' the scientific spirit — the higher level of understanding of science — people must first have a better understanding and mastering of scientific knowledge and methods. Just as the Chapter 7 of *Science and Engineering Indicators 2010* mentioned: 'Americans' understanding of scientific inquiry is strongly associated with their factual knowledge of science and level of education.'[7] So the questions here are:

- With the situation of 85% (100% - 14.67%) of Chinese people who don't master basic scientific knowledge, and 90% (100% - 9.75%) of Chinese people who don't master basic scientific methods, how can nearly two-thirds (64.94%) Chinese people 'worship scientific spirit'?
- Or, looking at it from a different angle: half (64.94% - 14.67% = 50.27%) Chinese people without mastering scientific knowledge

and more than half (64.94% - 9.75% = 55.19%) Chinese people without knowing scientific methods, can 'worship scientific spirit'! How could it be?

- What kind of 'scientific spirit' do these Chinese people worship or understand? What is the basis for their 'scientific spirit'? According to the logic of the 2010 investigation, if to 'worship scientific spirit' without knowing scientific knowledge and methods can be a part of scientific literacy, could the scientific illiterate people also have scientific literacy? Obviously, there are bugs/problems in the investigation system, such as what the connections are between scientific spirit and scientific literacy? And it also shows that the designers of this questionnaire misunderstood science literacy itself.

Through different interviews, the author of this report found in some districts and counties of Beijing that local CAST asked the residents to remember all the answers of scientific literacy questionnaire because the higher officers had pressurized them to improve the scientific literacy level of the local people — such as the national aim of scientific literacy was 5% in 2015, and the newest aim is 10% by 2020.

In fact, when other countries introduced the scientific literacy system of Jon Miller which has three parts as scientific concepts and knowledge, scientific methods, and science effect on society, they found especially the third part (science effect on society) is difficult to evaluate and compare. For example, one of the terms in the third part is 'astrology' which is not familiar to most Asian people as it has western culture characteristics, and China changed 'astrology' to 'fortune telling'. As a result, Jon Miller at last cancelled the entire third part of his system which certainly affected the initial definition of scientific literacy, and now most of the international investigations and comparisons just use the first part of Jon Miller's system which is the basic and classical scientific knowledge, and so the term 'scientific literacy' has gradually disappeared in many international investigations.

However, China still uses 'scientific literacy' in its relative investigations and also keeps all the three parts of Jon Miller's system, of course changing its contents from time to time, such as using the new term of 'scientific spirit'. The main reason maybe it is very difficult for China to change its long-term strategy,

especially because the 'The National Action Plan of Scientific Literacy for All Chinese Citizens (from 2006 to 2020)' (used to be the Project 2049 initiated in 1999) had the wrong aim for science popularization in China. The reason is that CAST learned a lot from the American Project 2061 which actually is a reformation of formal education from K to H12 (kindergarten to high school 12th grades) for its designing of Project 2049, but CAST changed the latter one into a complete science popularization plan which was almost controlled by CAST itself.[8] I will echo this problem again in the next topic.

Is Science Communication for Scientific Literacy?

What happened in Iodine Salt Rush-Purchasing Tide in China

After the 3.11 earthquake and tsunami in Japan 2011, especially when the Fukushima Dai-Ichi nuclear accident happened, there were mainly two news on Internet communicated very quickly in China — one was that iodine could be helpful to deal with nuclear radiation as the Japanese government had distributed drug tablets of isotope iodine 131 to local residents around nuclear plants. The other was nuclear radiation from Japan would pollute the East Sea of China and the salt, which is produced from sea water, will be unsafe and more expensive later on. So, if one did not buy iodine salt immediately it would be difficult to get it in the future — at least the quality of iodine salt won't be as good as usual and will be more expensive. As a result, there was panic among the Chinese people who crashed into almost every shop, store and supermarket in different provinces, cities and towns to buy iodine salt — it seemed as if a nuclear radiation disaster had struck China too.

This iodine salt rush-purchasing tide first appeared in Zhejiang province and Shanghai city which are along the east coast of China facing Japan directly on March 16, then spread quite fast to almost all over the country until March 18 such as Yunnan, Gansu and Sichuan provinces which are the inner lands of China and thousands of kilometres away from the East Ocean side of China. During the climax of iodine salt rush-purchasing tide, a lot of people bought from several, to dozens of kilograms, even tons of salt for their homes, and when the iodine salt was sold out temporarily in a supermarket people rushed to purchase iodine wine, iodine soy sauce, iodine tablets, and masks, etc. A citizen in

Wuhan City bought 6.5 tons of iodine salt, which could be consumed for 3561 years according to the calculation of a local newspaper.[9] A man in Zhejiang province even ate too much iodine salt in one time to prevent the effects of 'nuclear radiation' and died in the emergency department of a hospital, becoming the first victim outside of Japan during its nuclear accident.[10]

As time went on, due to both the proficient provision of iodine salt in the national markets and also limitation on individual purchase (two bags of salt which is about one kilogram for each person) by the government, and also popularization of more rational information by the mass media, new kinds of media and experts, the iodine salt rush-purchasing tide weakened gradually and almost disappeared on March 19. Some people even began regretting their impulsive purchasing action and wanted to return back the excess iodine salt they had bought home — this caused another relatively smaller tide of returning back iodine salt especially in the big cities of Guangzhou, Zhengzhou, and Shanghai.

During and after the iodine salt rush-purchasing tide, different media and experts provided analyses and reflections, the new media such as blog and 'new experts' — professionals with expertise such as science communicators' websites and expert individual's blog played even more efficient roles than scientists in their uni-directional science popularization. However, the main opinion was that the Chinese people have so low level of scientific literacy that they could not judge the right (scientific) way to face this sudden emergency.

As per other opinions, the public did not trust both the government and experts; the information from the mass media led to confusion among the people particularly at the beginning of the iodine salt rush-purchasing tide — usually people are irrational and just follow others blindly. A review on national media was as following:

'The China Central TV (CCTV, the only national TV in China) said the Japanese Fukushima Dai-Ichi nuclear plant would not explode, then it exploded.

The experts said immediately those two nuclear generator machines would not explode, then they exploded too.

The experts said again that even if the nuclear plant exploded, its

shell would keep it safe and sound, as a result there would be no nuclear radiation pollution at all, but the plant shell was blown away.

The experts comforted us that small radiation would not pollute the environment, then the Tokyo government announced that local nuclear radiation level is much higher than safe standard!

Just now CCTV broadcast again that China is surely safe and sound! My tears come down: should I believe it again?'

From this review on Internet, we can understand that while on the one side, the mass media and experts lost both public and academic authority, on the other side, the general people could not trust them again. And, one of the most interesting things is: how could this happen during the iodine salt rush-purchasing tide which continued only for a couple of days in China?

Science communication did not improve scientific literacy and should not?

The iodine salt rush-purchasing tide in China is a very good case of science communication study of public related to disaster. At the beginning of the rush-purchasing tide the public couldn't get the right and enough information from government, mass media and experts. There was various and conflicted information which just caused more confusion. For example, in the announcements of many local governments (who usually got professional suggestions from experts and controlled the local mass media) there was no information that iodine salt in fact couldn't prevent the nuclear radiation of isotope iodine 131, which showed that the governments (including traditional experts and mass media) didn't know what correct information should have been provided to the people.

The general public got a psychological sense of safety at a relatively lower cost — several bags of iodine salt at a low cost. The public devised their own ways to deal with the emergency situation which may not be scientific but it worked; people learned and imitated from each other and got both confidence and comfort from each other.

The governments (including traditional experts and media) 'lost' in the arena of communication and the public 'went' their own ways — this just shows the real problem both in 'science' (literacy) and 'communication'.

Many experts opined that the government and media should pay more attention to science popularization (SP)[4] to improve the scientific literacy level of the Chinese people. However, on one side science popularization has not improved the general people's scientific literacy level according to several national investigations first by the Ministry of Science and Technology (MOST) and second by the China Association for Science and Technology (CAST), on the other side, the aim of improving the scientific literacy level in fact never matches the concrete needs and different expectations of people especially during an emergency.

The 9 investigations of Chinese civil (from 18 to 69 years old) scientific literacy (SL) were held individually in 1992, 1994, 1996, 2001, 2003, 2005, 2007, 2009/2010, and 2015 but only the three reports of investigation in 2001, 2003 and 2009/2010 were published. As the questionnaire of 2009/2010 is different from 2003 and 2004, so here we just cite and analyze the latter two reports. From the results of these two investigations we can see that the Chinese civil scientific literacy level increased obviously with increasing numbers of formal education years of the public in school.

In China the general public accepting the systematic science formal education in school is only beginning at middle school stage, which means Chinese people who have just primary or under primary education in school could not get the science education experience, and these kind of people in China are more than 100 million. The SL level of these people, which is contributed mainly by science popularization during their life

Table 1 — The SL percentage of Chinese people with different formal education stage[12]

Investigation Year / SL / education grade	Under primary school	Primary school	Middle school	High school or prof-school	College	University and above university
2001	0.1	0.0	0.3	1.6	7.0	11.5
2003	0.0	0.0	1.5	6.2	10.7	13.5

4 In China In China now, the government often uses science popularization as an official term, the academic community usually use the term science communication, however they mean almost the same thing.

span from 18 to 69, is nearly zero according to the investigations in both 2001 and 2003. So, science popularization in fact contributes very little to the improvement of scientific literacy level of public especially when compared with the formal science education.

Science communication now implies respecting, understanding, negotiating, cooperating, and providing services concerning science for the public. Unlike school students, the general public does not have enough time and energy to continue to learn huge amounts of scientific knowledge; second, the interests and needs of public concerning science are so varied and also change frequently during their life span that just to improve the scientific literacy level of public is definitely not a cure-all.

Science communication does not mean communication of the scientist's science — scientific knowledge, data, facts, theories. This is why we could observe that some people in Hong Kong, USA, Russia, Finland who are thought to have much more higher level of scientific literacy than the Chinese people, also rushed to buy iodine tablets, iodine salt and masks during the same days[13]. Residents in Sakhalin Oblast (east of Russia) ran to purchase iodine wine, and any agent that had iodine, even general red wine was sold out too[14]. In China, people both in Zhejiang province and Shanghai city, where the iodine salt purchasing tide began, are also at the higher level of scientific literacy compared with other provinces.[15]

So, there is need for a new orientation of science popularization today which means instead of asking people to get to master more and more scientific knowledge from scientists, it would be better for science popularization to meet the various needs of the public such as material benefits, recreation expectation, and democratic rights etc. concerning science issues in modern society.

In conclusion, the relatively lower level of scientific literacy of the Chinese people is not the main reason for the 'crazy' and 'stupid' iodine salt rush-purchasing tide in China. It also shows in fact that real public scientific literacy cannot be improved so quickly by a 'great leap forward'. Nowadays science communication does not mean just improving the so-called scientific literacy of the public. In fact, science communication not only cannot but also should not improve scientific literacy because today's science communication is a multi-directional and

interactive feeding back communication which should be between all the stakeholders such as government, scientist, media, public, individual.

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