A Study of the Structure of Public Attitudes toward Science and Technology in China

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Abstract--**Based on the data of Chinese public understanding towards science survey in 2010, it has set some items to get general public attitudes toward science and technology. In order to study the features of different people attitudes toward science and technology, we have developed a two-dimensional model of attitude toward science and technology fitted in China which was tested by the confirmatory factor analysis (CFA), one dimension was Promise of science factor and the other one was Reservation about science factor. Through this model we got the structure of attitudes toward science and technology of different people in china, which is helpful for science policy-making and other fields of social research.**

I. INTRODUCTION

The study on public attitudes toward science can be traced back to 1957,[1] the first national survey of public attitudes toward science and technology (S&T) was conducted in United States. With the development of science and technology, public attitudes toward S&T played an important role for policy making and supporting scientists' research, for this reason United States and other major countries in the world had set series of surveys to learn how public understood science, how did public got access to S&T information and their attitudes toward science. [7]

The Law of the People's Republic of China on Popularization of Science and The public science literacy program of China which had been implemented since 2003 and 2006 showed that civic scientific literacy and public attitudes toward S&T became an important part of the Chinese government's work. With the rapid development of Chinese economy was accompanied by increased environmental pollution in recent years, the public view on S&T wasn't remain blindly optimistic, people were likely to hold different views on S&T. Genetically modified food, nuclear power had become hot public issues in china. Therefore, to get the patterns of general attitudes toward S&T could help us to choose reasonable strategy of science communication, which would make better results.

China had conducted the survey of public scientific literacy since 1992, [8] which also contained three main parts like other surveys in the questionnaire. Based on the 8th civic scientific literacy survey data in 2010, this paper extracted fundamental factors of the public attitudes toward S&T by Confirmatory Factor Analysis (CFA), and according to the "knowledge - attitude - practice" mode, using two strong correlated variables of respondent educational level and age to classify the individuals. With the different attitudes categories, it had been able to get patterns of how people treated science and what's their evaluation and prospects of science.

II. CONCEPT DEFINITION

An **attitude** is an expression of favor or disfavor toward a person, place, thing, or event (the attitude object). Attitude can be formed from a person's past and present. Attitude is also measurable and changeable as well as influencing the person's emotion and behavior. This definition of attitude allows for one's evaluation of an attitude object to vary from extremely negative to extremely positive. [3]

General indicators of public attitudes toward S&T in China and other countries are almost the same. It covers views of the promise for government funding of research, confidence in scientific community leaders, perception of the proper influence of scientists on controversial public issues, and views of S&E as occupations. Miller's work on science attitudes in the United States over the last five decades and cross-national comparisons found that attitudes can be best described as falling on two dimensions – (1) the promise of science and technology and (2) reservations or concerns about the impact of science and technology. [5]

III. CONFIRMATORY FACTOR ANALYSIS OF PUBLIC ATTITUDES TOWARDS S&T

It had been set 15 items to evaluate general public attitudes toward S&T in the questionnaire of Chinese civic scientific literacy survey in 2010, which were mainly for the performance of science and technology to bring the impact of human life, and individuals' expectation for the development of science and technology and the relationship between S&T and nature resources. In order to avoid too much interfered items from other dimensions, 2 items for **expectation** of S&T development and 2 items for S&T **impact** on human beings had been chosen to get individuals' view on evaluation and prospects of S&T. The values of each item were assigned a range [-2, 2] from a positive and optimistic attitude to negative and concerned attitude, in addition, the reversed item (B1_D25) was transposed to the same sequence of other items. In this case, the score range of each factor from -4 to 4, high score meant more positive and optimistic attitude for the development of science and technology and its impact on human beings.

A confirmatory factor analysis of the Chinese data in 2010 demonstrated this two dimensional structure (see table 1). A loading of 0.40 or higher was broadly accepted as being a reasonable fit.[2] Higher values indicated an even closer fit between an item and the underlying dimension, and lower factor loadings signal that an item was a less close fit. In general, the two groups of items showed the result clearly for the expectation of S&T development and S&T impacted on human beings were two factors pattern well fit in this study.

TABLE 1: FACTORS OF ATTITUDES TOWARD S&T

Factor	Item	Content	Component	
Impact	A1 (D1_1)	Science and technology make our lives healthier, easier and more comfortable.	.748	.057
	A2 (D2_2)	The benefits of science are greater than its harmful effects it may have.	.667	.143
Expectation	B1 (D2_3)	Technological discoveries will eventually destroy the earth.(reversed item)	.025	.711
	B2 (D2_5)	Thanks to scientific and technological advances, the Earth's natural resources will be inexhaustible.	.186	.664

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

TABLE 2: SCORE OF ITEMS AND FACTORS

	Minimum	Maximum	Mean	SE
A1	-2	2	1.60	.612
A2	-2	2	1.09	.945
Impact	-4	4	2.69	1.193
B1	-2	2	0.32	1.306
B2	-2	2	-0.20	1.460
Expectation	-4	4	0.07	1.920

IV. ANALYSIS OF THE EXPECTATION AND IMPACT FACTOR

The mean score of impact factor was 2.69, which indicated Chinese people held the strong positive attitude for the good and beneficial part from science and technology in general, however Chinese people showed their cautious attitude for the expectation of S&T development, the mean score of expectation factor was just 0.07 in general, it was a totally neutral score, as it could be seen from table 2.

In practice, an individual could have varying levels of belief in the current or future benefits of science and technology and simultaneously had some reservations or concerns about the benefits or promise of science and harbor few concerns about any potential negative impact. Other individuals might hold the opposite set of views, expecting few benefits from science or technology and numerous current or potential negative consequences.

According to the "knowledge - attitude - behavior" mode, educational level of individuals could reflect their understanding and knowledge about science, which was the crucial factor caused the distribution of individual attitudes toward science. Moreover, age was anther main factor for the distribution of individual's attitude toward science due to the intergenerational features of each generation.

For the impact factor, general public attitudes were strongly positive, the gradually increasing score indicated that individuals with higher educational level were more likely to hold positive attitude toward S&T impact on human beings, basically it was a linear relationship between S&T impact factor and individual's educational level, as it was shown in Figure 1.

For the expectation factor, although it was a totally neutral score for general public, there was a clear division of attitudes among different educational levels of individuals. Individuals with low educational level were more likely to hold optimistic attitude toward the expectation of S&T, in contrast individuals with high educational level were concerned about the expectation of S&T. The turning point of the attitude toward expectation of S&T was the high school level of education. The curve of slight changing score of expectation showed us that Chinese people were cautious about S&T future development, and individuals' attitudes turned from slight optimistic to slight concerned with educational level increased, as it was shown in Figure 1.

Theoretically, the more positive attitudes of one thing, the expectation would be more optimistic. However, this universal pattern was not followed by individuals' attitudes toward S&T in china, on the one hand, people agreed the positive impact of S&T, on the other hand people just held rational and cautious attitudes toward the expectation of S&T development. Generally, highly educated individuals they learnt more knowledge and better understanding of science and technology, due to this comprehensive understanding of S&T, they knew what positive parts of science offered us and what negative parts of science brought us, which caused the strong tension during optimistic impact of science and concerned about expectation of S&T, behind this attitude it reflected their rational and conservative thought to S&T.

People with different age had different attitudes toward S&T, the advancement of technology has brought tremendous convenience and productivity improvement to human beings since the middle of last century, people lived in that era were confident and trusted in science, but Chernobyl nuclear power plant spill and increasingly serious industrial pollution made people realize the negative parts of science and technology development.[6] Due to the huge changes in Chinese society over the past few decades, it could be learnt from figure 2 that individuals born in different years showed their different attitudes toward S&T.

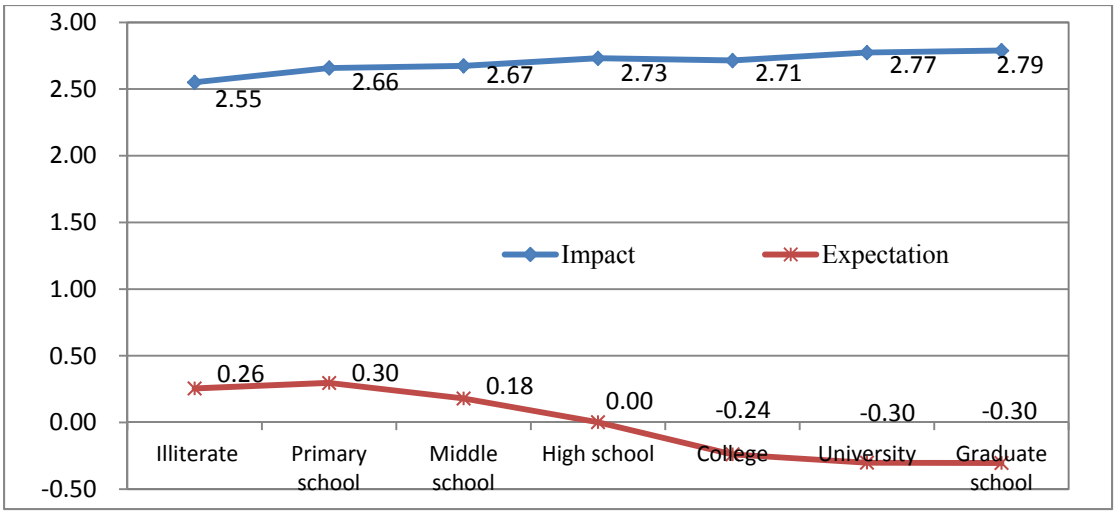


Figure 1: Impact and expectation of individuals with different educational level

For the impact factor, individuals with increasing age were more likely to hold positive attitude toward S&T impact on human beings, basically it was a linear relationship between S&T impact factor and individual's age.

For the expectation factor, it was also a linear relationship between expectation of S&T and individual's age, individuals with increasing age were more likely to hold optimistic attitude toward the expectation of S&T, however new generation (born after 1980) in china showed their negative expectation of S&T. Unlike the pattern of the relationship between science and educational level, individuals with age increasing their attitudes toward expectation of S&T showed the same trend as the impact factor that the older individuals were likely to show their optimistic attitude toward impact and positive attitude toward expectation of S&T.

V. CLASSIFICATION OF INDIVIDUALS' ATTITUDE TOWARD S&T

According to the above analysis, individuals with different ages and educational levels had different attitudes. The score of expectation factor was set as horizontal axis, and the score of impact factor was set as vertical axis, the mean of impact factor score was set as reference line and the 0 points of expectation factor score was set as reference line. With above sets, a four-quadrant diagram was formed to describe each classification of attitude toward S&T by putting these cross attributes of individuals into it, as it was shown in Figure 3. It could be found regular distribution from the four-quadrant diagram, which indicated that individuals held different attitudes toward science and technology fell into its quadrant in terms of their demographic variables.

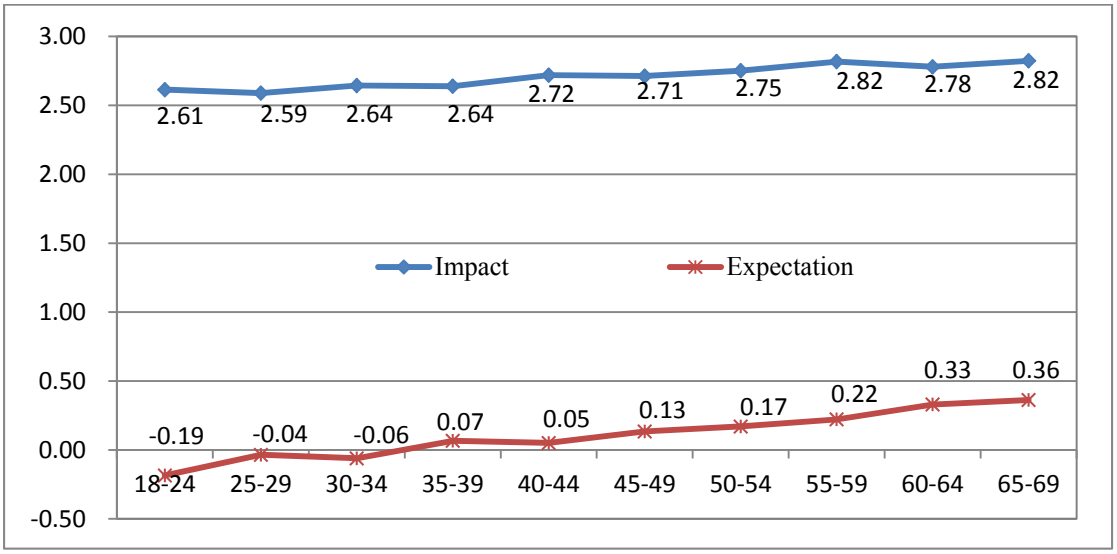
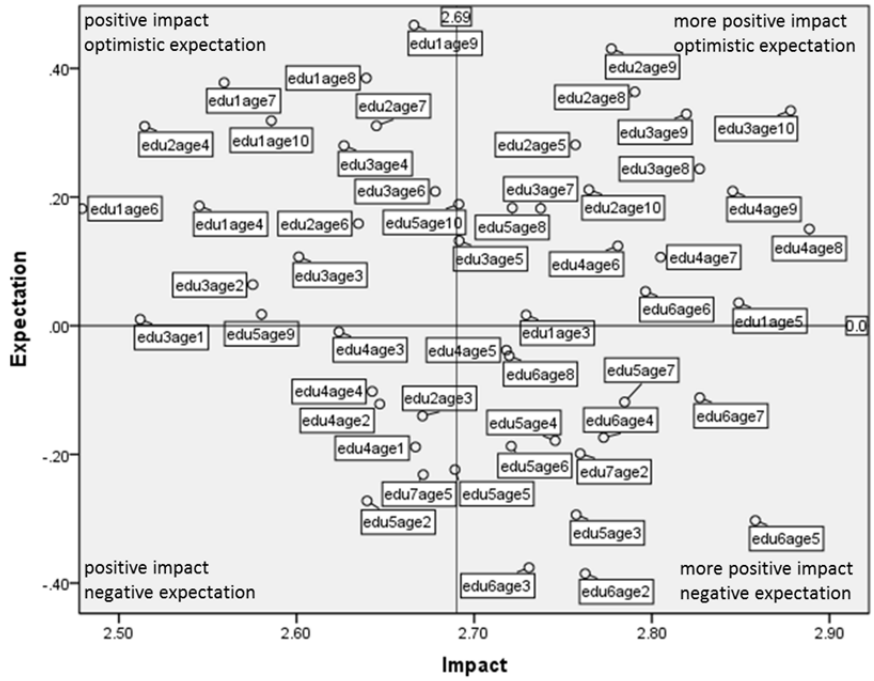


Figure 2: Impact and expectation of individuals with different age



(edu1-7: Illiterate, Primary school, Middle school, High school, College, University, Graduate school; age1-10: 18-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69)

Figure 3: Classification of individuals with different educational levels and ages for Impact and expectation

The definition of each quadrant had its meaning, the first quadrant meant individuals who held more positive attitude toward S&T impact and optimistic attitude toward expectation of S&T, it could be found individuals with old age and not high educational level were more likely to hold this type of attitude, the second quadrant meant individuals who held positive attitude toward S&T impact and optimistic attitude toward expectation of S&T, it could be found older individuals with low educational level were more likely to hold this type of attitude, the third quadrant meant individuals who held positive attitude toward S&T impact but negative attitude toward expectation of S&T, it could be found young individuals with low educational level were more likely to hold this type of attitude, the fourth quadrant meant individuals who held more positive attitude toward S&T impact but negative attitude toward expectation of S&T, it could be found young individuals with high educational level were more likely to hold this type of attitude. In short, four-quadrant distribution of individuals' attitudes toward impact and expectation of S&T proved group characteristics of attitude toward science.

VI. DISCUSSION

As a main part of civic scientific literacy survey contents, indicators of public attitudes toward S&T provided much data and information for researchers. Considering attitudes toward S&T were multidimensional structure, it had to choose proper factors to describe one side of the image of public attitudes toward S&T. Generally, S&T impact and expectation of S&T was a pair of related factors to evaluate and prospect S&T, it was a meaningful study to find patterns of individuals with different ages and educational levels they treat S&T, and from analysis of this paper we found the classification of individuals in china, which could be used for public policy making and other researches. Therefore, finding the right factors of public attitudes toward S&T was the key point for this classification study.

In this paper, based on two basic factors of impact and expectation of S&T, and chose two demographic variables from the mode of "Knowledge - attitude and behavior" to do cross-analysis. The results showed that individuals with different educational levels and ages held different attitudes toward S&T, it could be grouped into four categories of attitudes. Individuals of different types of attitudes pattern had its own features of getting access to science information, participating S&T activities, understanding of science, it required to take different measures of science communication to improve the relevance and effectiveness of science popularization in china.[4] This paper provided a new way to discuss the initial classification of individuals' attitudes and its features in china, which could be a reference to do further study for individuals' attitudes and behaviors to S&T.

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APPENDIX TABLE:

ITEMS OF PUBLIC ATTITUDE TOWARDS S&T OF CHINESE CIVIC SCIENTIFIC LITERACY SURVEY IN 2010

Item	Content
D11	(1) Science and technology make our lives healthier, easier and more comfortable.
D12	(2) Thanks to science and technology, there will be more opportunities for future generations.
D13	(3) Even without S&T, people can live very well.
D14	(4) Scientific and technological progress will help to cure illnesses such AIDS, Cancer,etc.
D15	(5) We depend too much on science and not enough on faith.
D21	(1) Science and technology cannot sort out any problem.
D22	(2) The benefits of science are greater than any harmful effects it may have.
D23	(3) Technological discoveries will eventually destroy the earth.
D24	(4) Scientists should participate in science communication to get people know more about the new development of science research.
D25	(5) Thanks to scientific and technological advances, the Earth's natural resources will be inexhaustible.
D31	(1) In general, scientific and technological development will create more jobs than they will eliminate.
D32	(2) Citizens' understanding and support of scientific and technological innovation is the foundation of promoting innovative national construction.
D33	(3) Scientists should be allowed to do research that causes pain and injury to animals like dogs and monkeys if it can produce new information about serious human health problems.
D34	(4) Even if it brings no immediate benefits, scientific research which adds to knowledge should be supported by Government.
D35	(5) Government should engage citizens in science and technology policy decision-making more effectively through a variety of ways such as hearing.

Six options for each item: 1.Strongly agree 2.Tend to agree 3.Neither agree nor disagree 4.Tend to disagree 5.Strongly disagree 6.DK