Chapter 13
An Overview of Research on Informal Science Learning Among China's Youth

Fujun Ren and Jingying Wang

13.1 Historical Development of Informal Science Education

Since the time of the Opium Wars (1842) in the mid-eighteenth century, democracy and science have evolved into a collective pursuit for the Chinese people. Informal science education in modern China can be traced to the emergence of community organizations that were founded in the early twentieth century and prevailed in the 1920s and 1930s. Saving the nation through science and technology was the internal driving force of these organizations. This can be contextualized in view of the coercive inception of China's modernization, marked by the Opium Wars. After Western gunboats blew open the nation's door, Chinese intellectuals began to explore ways of safeguarding the country's survival, power, and resources. To these ends, they first drew on advanced Western science and technology, with a particular military emphasis. Local informal science education societies first appeared during this time. Scientific societies that emerged during the late Qing era and in the succeeding Republic of China proliferated rapidly, focusing on applying science and technology to everyday life. Libraries and educational and science museums became important modern public education assets that promoted the development of informal science education. Lecture halls, public schools, and

F. Ren (✉)
China Research Institute for Science Popularization, No. 86, Xueyuannanlu, Haidian District, Beijing 100081, China
e-mail: hljrenfujun@126.com

J. Wang
China Research Institute for Science Popularization, No. 86, Xueyuannanlu, Haidian District, Beijing 100081, China

Capital Normal University, Beijing 100048, China

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exhibition rooms were also created as venues for informal science education. From the late Qing period onward, informal science learning activities developed gradually. A system of informal science education was initially formed, led, and operated by nonprofit and nongovernmental societies and associations, with government advocacy, support, and promotion.

In the mid-1980s, rural and urban economic development, rising social production forces, and improvements in the industrial, agricultural, and service sectors created new cultural and technical demands. The sense of urgency emanating from communities led to the emergence of accounting, sewing, English language classes in the cities, and tractor driving and agricultural techniques in rural areas, as required by the times. The elimination of illiteracy was aided by mobile teaching, whereby a few teachers taught students in different districts and engaged in mastery teaching that focused on selected students, enabling them to learn well.

Short-term correspondence courses, broadcasts, television, and popular science lectures also began to emerge. As public's appreciation of science grew in China, and the government promoted scientific literacy as part of a harmonious modern society, informal science education expanded. This was achieved through the 2002 *Science Popularization Law* and the 2006 *National Scientific Literacy Action Plan*, which raised informal lifelong education to its peak as a necessary aspect of China's social and economic development.

13.2 The School Science Education Context of Informal Science Learning in China

The history of science and technology in China is both long and rich with many contributions to their development. Science education reforms in China initially concentrated on the knowledge and skills that students acquired from classrooms, gradually shifting to solving real-life problems through scientific inquiry. This process propelled informal science learning forward and highlighted the important role that informal science learning plays in science education.

13.2.1 The First Phase: Cultivating Basic Knowledge and Skills

Early Chinese education was reconstructed during this initial phase based on the education system and experiences of the former Soviet Union (USSR), which importantly influenced the direction of Chinese science education. China established the education goals of "basic knowledge and skills" and focused on systematic knowledge building.

13.2.2 The Second Phase: Cultivating Scientific Ability

This phase began in the 1960s with an explicit focus on cultivating scientific ability. Teaching outlines were established for all elementary and secondary school subjects that simultaneously emphasized basic knowledge and skills and cultivating students' analytical and problem-solving ability. During this period, scientific basics, ability, and education were emphasized for achieving well-rounded development. The teaching goal was to cultivate and develop scientific thinking, observation, experimenting, and self-studying abilities. Although knowledge-centered theory emphasizing systematic knowledge and its verification prevailed, STS (science, technology, and society) education and an integrated curriculum were also focal areas. Additionally, the mastery learning method, curriculum theory, and Bloom's taxonomy were influential during this phase of science education.

13.2.3 The Third Phase: Cultivating Scientific Literacy

This phase began during the 1990s and entailed three kinds of transformation that emphasized the functions of informal science education. The first was evident in the goal of science education that focused on all students and emphasized the development of scientific literacy, creativity, and practical ability (Wang and Yuri 2012). The second related to the science curriculum and emphasized the relationship between the curriculum and students' practical and experiential worlds, promoting the interdisciplinary study of technological development in the society. The last transformation entailed a practical view of science education that led to an understanding of the scientific process, the nature of science, and the value of science, cultivating the ability for scientific inquiry, sensibility, attitude, and valuation in students. Some of the critical literacy abilities associated with self-directed study of science such as critical thinking, information source select and critique, and languages of science began to be noticed as part of the scientific literacy framework only in China in recent years.

13.3 Theoretical Framework for Studying Informal Science Learning in China

Informal science learning is directly guided by core administrative theory on the division and mutual transformation of explicit and tacit knowledge. Commencing with the existing form of knowledge, knowledge management divides knowledge into explicit and tacit knowledge (Polanyi 1967). Explicit knowledge refers to words, images, and symbols recorded through print or electronic media. It is composed of programmed knowledge such as facts, natural principles, and scientific knowledge. Explicit knowledge has been publicized because of its effective and cost-efficient structure. People, therefore, have easy access to dominant knowledge in libraries, in the Internet, or through databases. Tacit knowledge is composed of cognition, emotion, beliefs, experience, and skills. These five elements are components of a person's mind and skills and are revealed through behavior. Because tacit knowledge is an inherent attribute, it is hard to express by means of language and written words. In informal science learning, the mutual transformation of explicit and tacit knowledge includes four steps: socialization, externalization, fusion, and internalization. Informal science learning is a process of implementing knowledge management (Tal 2012). This requires the following steps: (1) transforming knowledge from informal science learning into personal knowledge, (2) turning our individual experience and inspiration into understandable explicit knowledge, and (3) socializing personal knowledge and putting it into practice. Knowledge management of tacit knowledge is the key theoretical foundation of informal science learning in China.

Informal science learning occurs anytime and anywhere in natural settings. Learners can choose what to learn based on their interests. This choice is influenced by social construction and social constructionism. Both of these view society as an orientation and emphasize the social influences affecting individual development. However, social construction reaches further than social constructionism by putting society above individuals and studying its effect on individual learning within social settings. This approach is supportive of the basic concept that social interaction promotes human development.

13.4 Scope of Informal Science Learning Engaged by Chinese Youths

In addition to school time, two-thirds of students' time is spent in informal learning (Bell et al. 2009). Their activities during this time, therefore, have a far-reaching influence on their individual development (Cheng 1989). In order to understand the scope of informal science learning engaged in by Chinese youths, in 2010 we developed a questionnaire to survey Chinese youths. The questionnaire consisted of three sections pertaining to adolescents: ways of acquiring scientific knowledge and information, reasons for using out-of-school facilities for science education, and forms of adolescent representation and participation in out-of-school science education (Dillon 2012).

Based on stratified sampling, we chose 60 middle schools in Jilin, Hebei, Henan, Hubei, and Guizhou provinces. We sent out 4470 questionnaires and received 3670 completed questionnaires from students, including 1730 junior students and 1940 senior students.

13.4.1 Ways for Adolescents to Acquire Scientific Knowledge and Information

According to the status of informal science education, and of respondents as youths, the questionnaire listed 11 items relating to how youths could acquire scientific knowledge and information. This study was conducted in three districts of P. R. of China. From east to west, we chose Beijing, Henan, and Guizhou; we randomly selected 8th grade and 11th grade classes of four middle schools in each district with a total of 7126 students to participate in the study. The questionnaire contained six comprehensive questions, which contained two multiple-choice question and four description questions.

The survey indicated that class learning was the main and appropriate method for youths to acquire scientific information (73.6 %). However, a significant proportion of the youth widely used the Internet (54.5 %), television (41.4 %), and libraries (39.5 %) as their main method of knowledge acquisition. Fewer youths participated at scientific venues, and in scientific activities, or acquired this knowledge from newspapers and magazines. They rarely listened to broadcasts (see Fig. 13.1).

As shown in Fig. 13.2, urban youth made good use of the internet for communication. Given their location advantage, 5.1 % more urban youths used scientific venues than suburban youths. However, almost 16 % more suburban youths, compared with urban youths, made greater use of television for acquiring scientific information.

There were also gender differences, with 7.4 % more boys than girls browsing science websites and Internet videos and 7.6 % more boys discussing scientific topics. Girls were more inclined to acquire scientific knowledge and information from traditional media, such as libraries and magazines, with 9 % more girls than boys using magazines.

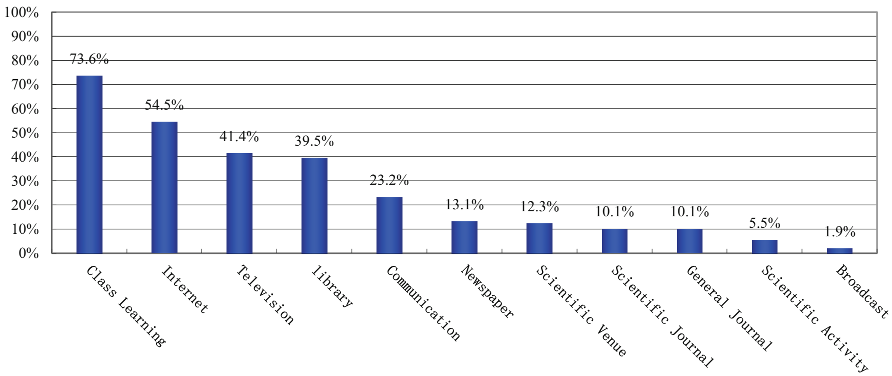

Fig. 13.1 Ways for adolescents to acquire scientific knowledge

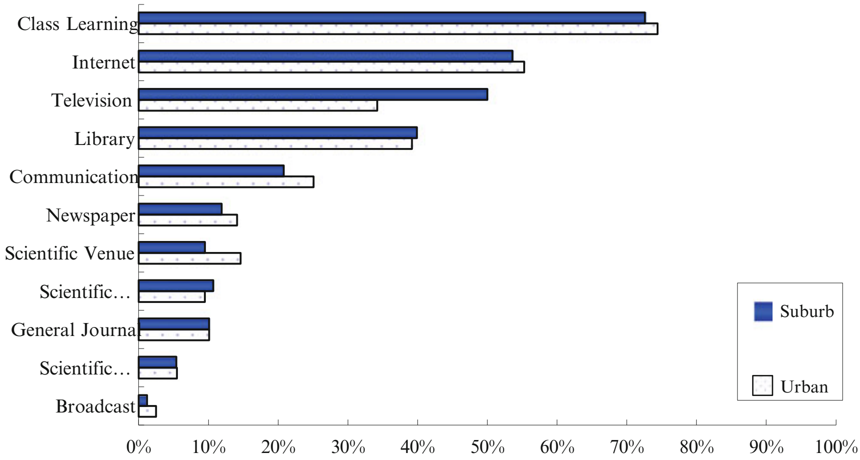

Fig. 13.2 Differences in acquisition of scientific knowledge and information between urban and suburban youth

13.4.2 Reasons for Using Out-of-School Facilities for Science Education

Adolescents widely used out-of-school facilities, such as zoos, aquariums, and botanical gardens (93.5 %), science and technology museums (87.5 %), and public libraries (83.9 %). At school, they also frequented library reading rooms (83.4 %). However, the use of some kinds of professional science and technology venues was evidently lower. In descending order, these were industrial and agriculture production zones (33.2 %), science and technology models or popular science activities and sites (28.6 %), and college or scientific research laboratories (25.1 %). Table 13.1 shows specific reasons for using and not using informal science education facilities. Visits by adolescents to the first four items listed as out-of-school scientific education facilities were based on their own interests. The main reason for their low usage of other professional science and technology sites was ignorance of their locations. Specifically, almost 45 % of adolescents did not know the locations of college or scientific research laboratories. A section of them expressed a lack of interest in these places.

The survey reveals that most adolescents acquired knowledge from popular science sites and facilities, with few youths perceiving that they had acquired nothing. Over half of the adolescents viewed public libraries (59.4 %) and science and technology museums (58.0 %) as useful facilities. Integrating these data with the data on less useful facilities, the highest percentages were found for science and technology museums (89.8 %), zoos (89.2 %), public libraries (86.5 %), and library reading rooms (81.3 %). Although professional science and technology sites were less commonly used, their percentages were also above 65 %. Even the least popular science galleries or public columns reached 61.6 %.

Table 13.1 Conditions of using out-of-school facilities for science education (%)

	Been to				Haven't been to				
Place name	Interest	With friends	School activity	By chance	None location	Ticket expensive	Less exhibits	Unknown location	No interest
Zoo, aquarium, botanical garden, aquarium	43.3	28.9	10.4	10.9	1.1	1.1	0.5	0.5	3.3
Science and technology museum, planetarium	36.0	18.8	24.5	8.2	1.6	1.4	0.3	2.7	6.5
Public library	55.9	13.6	3.5	10.9	0.3	0.8	0.5	4.9	9.8
Art gallery or exhibition	22.6	13.4	15.5	10.1	4.1	0.8	0.8	13.1	19.6
Popular science gallery or publicity column	13.1	6.5	7.9	19.6	4.4	0.8	1.4	19.1	27.2
Library reading room	51.2	9.0	7.1	16.1	0.3	0.3	0.5	7.4	8.2
Scientific and technology model or popularization of science activity place	7.1	5.2	6.8	9.5	7.6	0.5	1.4	34.6	27.2
Industrial and agriculture production zone	4.6	8.7	12.3	7.6	6.8	0.3	0.5	34.3	24.8
College or scientific research laboratory	5.2	1.9	10.1	7.9	9.3	0.8	0.3	45.0	19.6

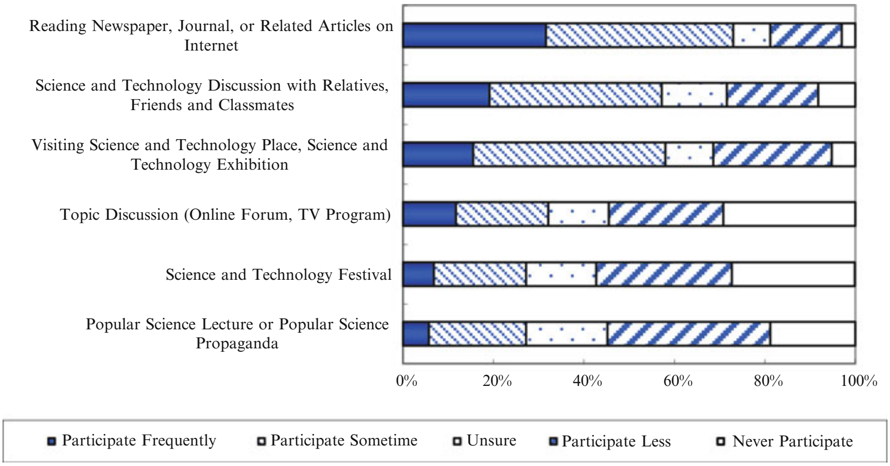

Fig. 13.3 Forms of adolescent participation in out-of-school scientific education

13.4.3 Forms of Adolescent Participation in Out-of-School Science Education

Adolescents were generally aware of many kinds of popular science activities, an exception being scientific broadcasts, of which 45.8 % of adolescents were completely unaware. However, in general, all adolescents who participated in this activity were enthusiastic. Most had not previously participated, but desired to do so after gaining some understanding. However, participation was generally low in these kinds of popular science activities, with science and technology exhibitions being the highest in this category at 44.4 %. As Fig. 13.3 shows, adolescents preferred to read newspapers, journals, or related articles on the Internet. While also communicating with others and visiting science and technology venues, they participated less in interactive discussions and in practical science and technology activities. Because most youths were the single child in their families, they also lacked communication and practical abilities. Moreover, these kinds of activities were not popular and attractive among adolescents. In particular, popular science lectures and other forms of popular science propaganda were unpopular.

13.5 Research on Informal Science Education in China

Although science education was first evident in China in the 1800s, the systematic study of informal science learning emerged rather late. Research on informal learning sprang up in Chinese academic circles in the late 1990s and gathered momentum by the early years of this century. Using journals retrieved from the

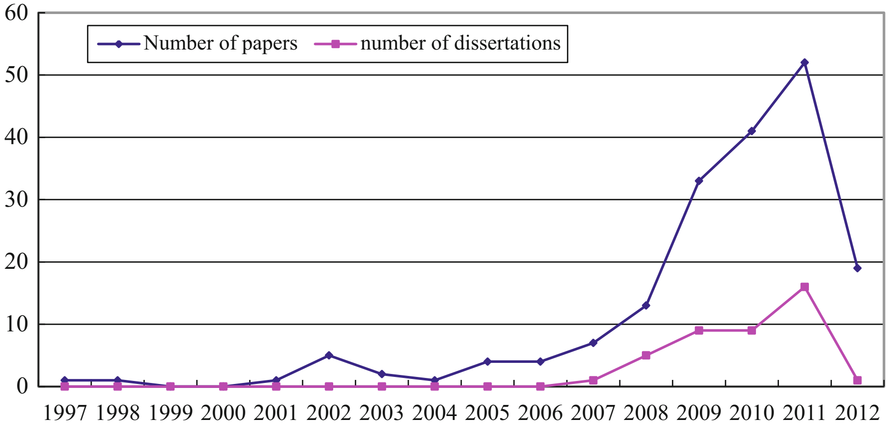

Fig. 13.4 Numbers of references related to informal learning (January 1997–May 2012)

Chinese National Knowledge Infrastructure (CNKI) database (www.cnki.com) as our major data source for analysis, we retrieved only a few articles by applying the keywords "informal science learning" and "informal science education." Considering research convenience and aiming to broaden the research scope, we then expanded the retrieval range and selected "informal learning" as our keyword sort and analyzed the current status and historical development of informal learning research.

By using the keyword "informal learning" in the CNKI search engine, we retrieved a total of 274 studies, including 26 dissertations and 248 academic papers published between 1997 and May 2012. After excluding irrelevant papers, 225 remained. Chronology statistics are shown in Fig. 13.4. It is evident that there was little domestic research done in this field before 2005. However, since 2008, "informal learning" has become a hot research topic. There is also a concentration of dissertations in this field during the last few years. From 2007 to the present, interest in informal learning research has shown an increasing trend. However, because our sample only extended to May 2012, this survey did not represent all informal learning studies published in 2012.

Our analysis of abstracts and keywords revealed six focal areas of informal learning research: theoretical studies, practical applications, virtual technology, current status, evaluation studies, and resource constructing. Numbers and percentages of articles on these subtopics are shown in Fig. 13.5.

To further understand the historical development of informal learning, we obtained chronological statistics in the six main research areas described above. The results are shown in Fig. 13.3. We divided the period from 1997 to 2012 into three phases: before 2005, 2005–2009, and 2009–2012. This was because the number of papers on informal learning began to quickly rise in 2009. Figure 13.6 shows the corresponding characteristics and focus areas during these three phases.

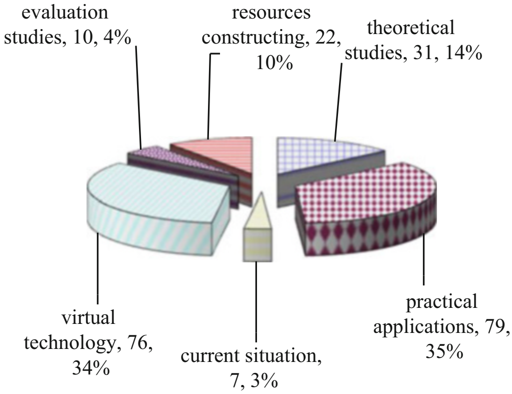

Fig. 13.5 Components of informal learning research

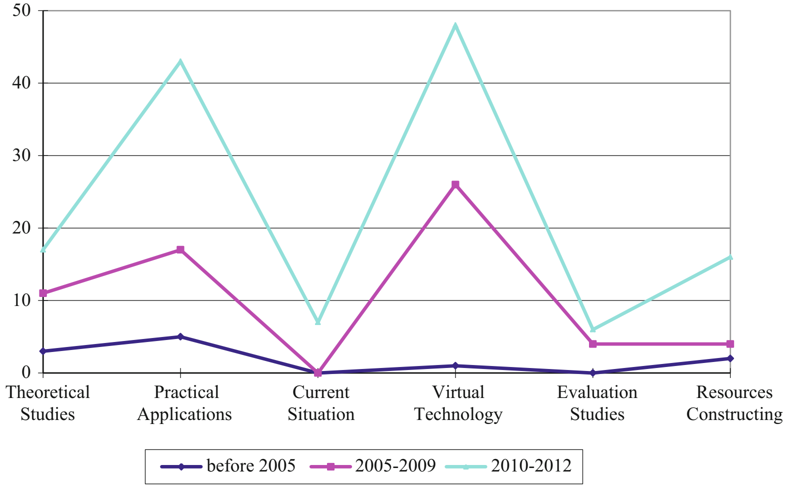

Fig. 13.6 Change of informal learning topics in different years

For a more detailed understanding of these trends, we analyzed the abovementioned research directions and their key aspects, as shown in Table 13.2.

During the first phase (up to 2005), "informal learning" investigations by Chinese scholars had only just started. Theoretical discussions on this subject mainly focused on the importance and significance of "lifelong learning." More practical studies were applied to adult and community education, but related research was relatively sparse.

During the second phase (2005–2009), studies in this area increased gradually. Theoretical research deepened, and related models, such as long-tail theory and tacit knowledge, were introduced by Chinese scholars. With the development of Internet networks and software, research on informal learning in virtual technology fields increased, as did the development of machine-based evaluation systems and resources.

Table 13.2 Research studies by different topics

Research topics	Contents	Number
Theoretical studies	Function and value of informal learning	5
	Conception and theoretical basis	15
	Review	11
Practical applications	Training	11
	Students' learning	14
	Classroom teaching	16
	Teachers professional development	24
	Informal learning of adults	14
Current situation	Undergraduates	4
	Teachers	3
Virtual technology	Digital media	4
	Micro-mobile terminal	21
	Micro-blog	9
	Society software	6
	Internet learning	35
	Game learning	1
	Distance education	1
Evaluation studies	Assessment of learning outcome	6
	Comparative research	4
Resource constructing	Platform construction	20
	Construction of learning resources	2

During the third phase (2010–2012), informal learning research conducted by Chinese scholars greatly accelerated. Chinese investigators began to theoretically focus on research results from the European Union, the United Kingdom, and the United States. During this period, more empirical investigations were carried out, which mainly addressed the status of informal learning among college students, graduate students, and teachers. This provided a reference for understanding the development of informal learning in China at a time when virtual technology was overtaking traditional technologies. Other mobile media such as microblogs, mobile phones, and network learning were evolving, and the study of new media also accounted for a large proportion of research. Research on resource development showed an upward trend, and the design and creation of learning communities and societies became the main research direction.

13.6 Discussion

In-class learning is the main method for Chinese adolescents to acquire scientific knowledge and information. At the same time, the Internet and television programs play an important role, whereas newspapers, journals, and broadcasts are less used.

Visits to science and technology venues and participation in popular science activities also have less appeal for adolescents. Regarding differences between urban and suburban youth, the former can acquire information by visiting science and technology venues because of their location advantage, whereas the latter acquire this through television programs (Paris 1997). Boys prefer to use the Internet, whereas girls prefer reading traditional print media to acquire information. Class learning should, therefore, be closely integrated with out-of-school science education. During classes, teachers should provide students with cutting-edge science and technology information that imparts knowledge connected to everyday life. This can motivate adolescents and arouse their curiosity regarding science and technology. Teachers should also make full use of new media. The Internet is a part of adolescents' lives and their acquisition of information. Establishing popular science websites that are tailored for and appeal to youths can motivate them to acquire more knowledge and not just entertainment from the Internet (Gee 2003).

Informal science education research in China can be divided into three phases from 1997 to 2012: preliminary, comprehensive, and empirical investigation. Some national scholars, who introduced foreign research results, have tended to divide informal science education into its informal existence in reality and a digitally constructed virtual environment. The former includes an individual's everyday life and family environment, as well as museums, science centers, botanical gardens, zoos, aquariums, and libraries (Ren et al. 2012). A virtual environment, on the other hand, is established through information technology such as the Internet, multimedia and virtual reality technologies, and online games (Rennie 2007). This classification mainly depends on different learning environments. Chinese researchers have also investigated informal science education environments based on community electronic media and popular science sites.

The historical trends and frequencies of the types and foci of research on informal science learning indicate growing interest in practical issues and virtual environments that are likely to set the trend in informal learning research in the near future. Their implications for future research may be in the areas of assessing learning outcomes and exploring the challenges of assessing science learning in informal settings. Informal science learning formats for young people in China can be divided into three categories: media, science popularization activities, and science popularization sites, and their results should be assessed for further development. Chinese researchers should construct evaluation frameworks as a tool for both planning and assessment, identifying areas that can be assessed in these informal settings. At the same time, we need to pay attention to the promotion of students' understanding of nature of science and scientific inquiry in informal science learning environment, and the integration of informal science education resources in different regions of China, and to optimize the educational resources.

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