Chapter 16
Students' Views of Science Learning During Visits to Science Museums: A Case Study

Lihui Wang

16.1 Introduction

Learning in museums is an important way to promote the understanding of science. It is evident that as a learning venue, the museum has a positive role in promoting the active learning process to students (Allen 1997; Crowley et al. 2001; Bell et al. 2009). The constructivist model (Hein 1998) of the museum-based learning approach emphasizes that learners construct new knowledge through active engagement with their own experience and existing knowledge. Museum-based learnings can improve students' interest in science. A study on the long-term effects of learning in museums conducted by Falk and Dierking (1997) found that field experience in museums produced a lasting influence on pupils' lives. In another study, Jarvis and Pell (2005) found that girls 10–11 years old who lacked confidence in science learning thought this kind of visit was "real and very interesting." After having joined a challenging visit to the UK Science Centre, their anxiety about science learning was also reduced and their confidence strengthened. Many teachers and science educators also believe that learning in museums can help students gain new knowledge and develop their skills.

Since the passing of *the Law of the People's Republic of China on the Popularization of Science and Technology* (2002) and the *Outline of the National Scheme for Scientific Literacy* (*2006–2020*) (2006), the establishment of museums has progressed rapidly in China and may have already reached its peak. By the end of 2013, there were 678 science and nature museums and 380 science centers in China. The number of science and nature museums was 9.5 % higher than that of 2011.

L. Wang (✉)
China Research Institute for Science Popularization, No. 86 Xueyuan South Road, Haidian District, Beijing 100081, China
e-mail: wanglihui1001@sina.com

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More than 50 % of science and nature museums were located in eastern part of China. Some museums such as China Science and Technology Museum and Guangdong Science Center are very famous to Chinese students. The number of visitors to science and technology museums in 2013 went up to 98 million (Ministry of Science and Technology MOSAT 2014). To improve access to museums, the museums managed by the Culture and Heritage Department of the government have been open to the public for free since 2009, and from 2014 all science and technology museums offer free entry to young people. A survey conducted by China Research Institute for Science Popularization in Beijing at Zhongguancun Middle School showed that most students had visited science museums. Twenty-four percent of the students often visited science museums during weekend and vacations and 62.7 % of the students hoped to take part in projects and events offered at science museums.

With the developments of science and technology museums, Chinese scholars, who had been mainly concerned with science learning in schools, began to focus on the museum-based approach to learning science (Bai and Chen 2005; Xu 2007). Special attention has been paid to the informal learning which occurs in science museums. Some scholars became interested in using museum science learning as a supplement to school-based learning to promote science learning (Xie and Shang 2009). There are some studies from the constructivist perspective designed to understand the role of the museum as an avenue of science education (Wu et al. 2009; Chen 2003). However, there have been very few in-depth studies on the features of museum-based learning; most current studies are theoretical introductions. This chapter reports a case study of students' views of visits to museums in China. I intend to answer the following questions: What are the students' perceptions of the features of museum-based science learning? What is the perceived relationship between museum-based learning and school learning?

16.2 Theoretical Framework

Constructivism argues that humans generate knowledge and meaning from an interaction between their experiences and their ideas. This means that learners construct knowledge both individually and socially. The principles of constructivism give us fresh perspectives on museum learning (Falk and Storksdieck 2009). According to the constructivism theory, the museum can be seen as an experienced and perceived environment where the audience will be modeled as an active learner. That is, the learner can access knowledge according to their own interests in the museum instead of it be instilled in the classroom.

The theoretical framework of science and technology museum-based learning mostly adopts learning models based on constructivism. Based on this theory, Falk and Dierking (2000) propose the contextual model of learning. This framework draws from constructivist, cognitive, and sociocultural theories of learning, and the key feature of this framework is the emphasis on context. They believe that learning

is achieved through three contexts. First, the students are prompted to awaken their existing knowledge. Second, they are provided with new information. Third, they work with the new and existing knowledge and apply it to address new problems or issues (Atiomo 2009).

Compared with other educational forms, museum-based learning is quite unique. A museum is an informal learning space. Effective museum-based learning means that at the end of the visit, a visitor has a greater knowledge and understanding of a theme than at the beginning. When a visitor comes into an exhibition space, the learning activities mainly include reading text, listening to explanations, observing exhibits, watching videos, experiencing, and experimenting. In the museum, each exhibit provides the context for understanding the exhibit. When the exhibit is in a specific form, its knowledge and its relative significance are exposed.

16.3 Methodology

16.3.1 Questionnaire-Based Interviews

In this study I used a questionnaire-based interview of students. There were 24 questions in the questionnaire, and it was initially reviewed by two youth science learning research experts.

Based on the context model of museum-based learning, visitors, as a part of the museum, and their interaction with the exhibition and other visitors are an important way to learn. In the questionnaire, this study collected the influential factors of the pre-visit and in the middle of the visit. The questionnaire had five sections: (1) number of visitors and duration of visits to the science and technology museum; (2) the recognition/popularity of the science technology museum in school science teaching; (3) who was responsible for deciding to visit the museum; (4) the impact of the museum on the student's learning of science knowledge, including the motivation for learning and how to master the scientific method; and (5) the impact of the museum on the student's individual cognitive development. The reliability of the scales in the final questionnaire, based on Cronbach's alpha coefficients of internal consistency, was 0.703 and above.

16.3.2 Data Collection

The survey was administered on a weekend in December to all students who visited the China Science and Technology Museum and the Beijing Museum of Natural History who arrived and departed between 10 AM and 3 PM. Except for holidays, during the week, students in China are often organized to visit the science museums by schools, and the visiting time is limited. This study focused on individuals

during the weekend. The respondents' answers to the questionnaire were recorded by the investigators, each taking 5–10 min to complete. Of the 142 completed questionnaires, 140 were valid. There were 66 responses from the China Science and Technology Museum and 74 from the Beijing Museum of Natural History. I combined the data from the two museums for analysis. Of the visitors, 51.3 % were boy students and 48.7 % were girl students, while 86.7 % were primary school students and 13.3 % were junior high school students.

16.3.3 Data Analysis

In the survey, the investigators were coded as A, B, C, and D. Before the interview, the respondents were asked whether they had been interviewed. Each respondent was coded in accordance with A1, A2, A3. . .B1, B2, B3, and so on. The data were input into excel and analyzed by SPSS version 16.0. Frequency analysis was used to describe the data.

16.4 Results

16.4.1 Students' Views on Features of Museums as Science Learning Venues

Museum-based science learning is connected to learners' primary knowledge, and interaction is important in obtaining new knowledge. The analysis of students' views on science museums is as follows:

1. Relevance to prior knowledge. Prior knowledge is the origin of new knowledge. The students' prior knowledge mostly was learned from school. In response to the question "During your visit, did you use knowledge gained in the classroom to help understand the exhibits?" 63.5 % of the students answered that they did. However, there was a large portion of the students who gave a negative or an uncertain response. This means that those students were unable to link classroom learning with learning in the science museum. When asked "Did the visit to the museum increase your knowledge?" 91.3 % of them responded positively.
2. Emotional response to visits. Visiting a museum may result in pleasure, fun, and surprise, as experienced by 98.6 % of the students. Among the students, 53.5 % liked the exhibits and exhibition areas and had always been interested in science. The opportunity for a "hands-on experience" was liked by 13.2 % of the students, while 12.4 % of the students wanted an in-depth understanding of the knowledge learned in the classroom.

A specific scientist/astronaut/computer professional/biologist was admired by 93.4 % of the students, and more than half of them thought they would join the profession that related to the exhibits they liked in the museum.

3. Promoting exploratory learning. In response to the question "During your visit to the museum, have you tried to observe the scientific aspects of the exhibits from different angles?" 46.6 % of the students said that they had certainly been able to do so; however, 39.1 % of the students were unsure.

A large number (87.4 %) of the students who visited the museum thought the "do-it-yourself" tips helped them understand the scientific aspects of the exhibits. The question "Through visiting the museum, did you understand the science-related processes and methods of scientific inquiry?" received a 56.2 % positive response, but 38 % of the students said they were unsure.

4. The cognitive impact of the visits. Data concerning the students' individual cognitive investigations were collected mainly through the following four questions: (a) During your visit to the museum, did you find that the exhibits were logically organized? (b) Did looking at the exhibits/multimedia/touch-screen displays leave a clear impression in your mind? (c) During the museum visit, did you find that some of the exhibits made you think of learning certain concepts and how they worked? and (d) During the museum visit, did vivid and colorful presentation of images stimulate you to imagine and design something new? Positive responses from students to these four questions were 37.8 %, 91.9 %, 50.0 %, and 77.4 %, respectively.

According to the answers to above questions, it is possible that the exhibits helped students to form a three-dimensional impression in their minds and inspire them in the practical design of new things. But understanding the link between the exhibits and the principles behind them was difficult for a large proportion of students, and this is precisely the point of linking classroom learning with technology through visiting a museum.

16.4.2 Time Spent During Museum Visits

The main model of science learning in science and technology museums in China is that weekday visits to the museum are organized by schools, and weekend and holiday visits are arranged by parents or others. Organizing student groups to visit is the main way for most schools to use the museum; however, a quick "play" is not conducive to the learning experience of students in the museum. It is worth noting that this was the first visit for 59.4 % of the children and only 14.1 % had visited more than three times. It is evident that not many students visit the popular science venues frequently.

The behavior patterns of audiences in science venues vary depending on the composition of the audiences. Although the survey was conducted in winter when

Table 16.1 Duration of student visits to the museums

Visiting time	Frequency	Percent
1 h	4	2.9 %
2 h	25	17.9 %
3 h	44	31.4 %
4 h	35	25.9 %
5 h or more	28	20.2 %
Missing	4	2.9 %
Total	140	100 %

the weather was colder and daylight shorter, 57.3 % of the students spent 3–4 h (including eating and resting) visiting the museum, while 20.8 % of students spent less than 2 h. This indicates that the students who came to these venues stayed a considerable period of time to fully understand the layout of the venues and explore exhibits they wanted to learn from. Table 16.1 presents time spent in the museums.

Spending more time in museums and repeated visiting museum undoubtedly can be helpful to students' science learning, so parents and teachers should spend more time guiding students to learn from science museums.

16.4.3 Museum-Based Learning and School Learning

Museum-based learning and school learning are both important venues for science learning. In this investigation, I found museum-based science learning should be paid more attention:

1. Only 18.4 % of the students' schools had ever organized a visit to a science museum before. In the survey, I found that for science-related courses, only 29.8 % of teachers asked students to visit science and technology museums. However, 79.1 % of the students wanted to visit the museum and learn there. As a guide for the students in the classroom, the science teacher plays an important role in promoting informal science learning. If the teacher mentioned content in the classroom related to the experience of visiting the museum, either before or after visiting the museum, the students can combine their museum experience with classroom learning. This enables them to understand the relevant information better and faster and expands the breadth and depth of their knowledge.
2. Museum-based visits and students' interest in science. Museum learning takes place without any pressure; it can maximize the motivation of students toward learning and enhance individual interest in science. Based on our survey, I found that students became more interested in science. Among the students, 53.5 % liked the exhibits and exhibition areas and had always been interested in science. The reason for liking the exhibits for 13.2 % of the students was the "hands-on experience," and for 12.4 % of the students it was the knowledge: "I learned in

Table 16.2 Reasons for liking the exhibition

Selection	Frequency	Percent
Was always interested	69	53.5 %
Hands-on experience	17	13.2 %
Learned related knowledge on class	16	12.4 %
Wanted to have in-depth understanding	9	7.0 %
Others		
Missing	31	13.9 %
Total	140	100 %

the classroom, but I wanted to have an in-depth understanding." Table 16.2 presents the findings.

3. Cooperation between schools and museums. In the survey, nearly 80 % of the students wanted to have classes in museums, but there were few science museums that could provide science courses to students. One student was once a member of a "biology class taken in a museum" conducted by the Beijing Museum of Natural History, in which the class was co-taught by school teachers and museum experts, introducing courses about "biology and the environment" including animals, botany, paleontology, and anthropology. This student said that while learning in the museum, he could find the real exhibition corresponding to the pictures on the book and understand the theory more easily. His classmates and he all liked studying in the museum. There is still a lot of work required to build a bridge between museum learning and classroom learning in China, and there is also the lack of evaluation of learning effects on the museum audience.

16.5 Discussion

This chapter reports on students' perceptions of museum-based learning. In China, most parents and teachers recognize that museum-based science learning is important.

This study is about students' attitude of visiting science museums, and there are some limitations in the research. (a) In the questionnaire, interview questions might be leading respondents to certain answers due to the design; (b) the interaction with the exhibits, other visitors, and their parents in the museum is the important aspect of learning; because of the large number of subjects, there was no observation of visitors interacting with the exhibits; and (c) the comparison of the behavior before and after the activity can understand the learning effect of students, but this study did not choose specific science topics, so there was no knowledge of what students had learned in their classrooms before visiting the museum.

Constructivists describe learning as the process of constructing new knowledge by linking the already-mastered knowledge and experience of the learners with new

information. Exhibits showing daily life can help visitors understand scientific ideas, emphasizing the significance of already-mastered knowledge. Museum-based learning experience stimulates the inner motivation of students and helps them construct new knowledge using their cognition; as a result, students can understand new scientific concepts and knowledge. However, since families can have an important impact on students, parents should study with students and guide students' learning.

It is important to develop school-based learning enhanced by museum-based learning and to promote the integration between museum learning and school learning. School-based curriculum can be developed in response to schools' particular situations and needs. An excellent school-based curriculum can then be extended into informal learning places to cater to the individual needs of students. Based on the general characteristics of all museums, a school-based curriculum can be developed for primary and secondary students. The content of a school-based curriculum in science and technology should reflect the resources of the available museums. The curriculum may be designed to improve students' scientific literacy based on their mastered knowledge and experience, while recognizing their interests, and should take into account both the logical progression of knowledge development and the character of museum exhibits.

Exhibition is an important strategy to facilitate museum science learning. In order to enhance the ability of museums to provide primary, junior high, and high school education programs, museums need to strengthen exhibits' designs. Most students in our survey study thought exhibits and exhibitions were too general and lacked detailed information or were too abstract. The integration of exhibits and textbook scientific knowledge is necessary for students' science learning. In order to do this, museums need support from the formal educational sectors.

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