The Sarawak Museum Journal, LXXXV (106) (2022): 197-216

"FLIPPED MUSEUM" PATTERN: **AN EFFECTIVE WAY TO DEEPLY INTEGRATE MUSEUM EDUCATION WITH COURSE TEACHING**

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ABSTRACT

Education is well acknowledged as one of the core missions of university museums. Despite diverse education activities conducted, several problems do exist in practice, such as the lack of combination between the museum and university formal education, unsatisfied results out of traditional museum education approaches, etc. Based on the pedagogical theory of the "flipped classroom", a new pattern of museum education - "flipped museum" is promoted in the paper, which embeds museum education into classroom teaching as a "knowledge internalisation" link. The concept of "flipped museum" is illustrated in the literature review and further researched in way of the qualitative descriptive case study of four educational activities, focusing on the aspects of feasibility plans, basic characteristics, implementation significance, etc. The four cases are jointly conducted by Tsinghua University Science Museum and the departments in Tsinghua University deriving from the normal curriculum. It is demonstrated that the "flipped museum" pattern can promote the deep integration and mutual benefit between university museums and university classroom teaching, so as to improve the quality of higher education. Hence, during education processes, museum staff turn to be the close partner of teachers, bringing the educational value of museum exhibitions into full play.

Keywords: Flipped museum, museum education, university museums, science museums, higher education

INTRODUCTION

It is acknowledged that the university museum is an integral part of the museum family with a long history and distinctive characteristics and has a unique position in the development process of world museums. It presents a trend of rapid development in recent years. Whether it is the world's earliest public museum, Ashmolean Museum of Art and Archaeology, founded in 1683, or China's first museum, Nantong Museum, founded in 1905, all originated from universities. World-class universities all have their own high-level museums throughout the world, and Tsinghua University is actively building its university museum cluster.

Education is one of the critical functions of museums which is taken as museums' primary duty according to the International Council of Museums (Sandahl, 2019). As a British Museologist Eilean Hopper-Greenhill said, the museum itself is an educational institution, and all activities of the museum have educational purposes (Walsh-Piper and Hooper-Greenhill, 1994). Apart from shaping the cultural tradition of the university, there are two critical educational missions for university museums. One is to support student growth in the university, the other is to improve the scientific and cultural literacy of the public. The former is the foundation of the foothold, and the latter is the due meaning (Bradley, 2009; Wu, 2020).

There are several types of university museums, such as art museums, history museums, and science museums, with different educational objectives and implementation methods. Unlike western countries, university science museums started the latest and have the least number in China. Despite the cases in the paper embodying the educational activities of Tsinghua University Science Museum, the educational pattern deriving from the cases is also applicable to other types of university museums.

With the continuous exploration and practices by university museum staff, various education approaches have been carried out in university museums around the world, as well as in China, such as miscellaneous visiting activities around exhibitions, knowledge popularization courses, and workshops relating to all aspects of the museum, practice and research projects facing to the audience, auxiliary support for relevant course teaching (Matthias, 1987). However, generally speaking, the following problems are still common in the current university museum education.

(1) As a kind of informal education, museum education tends to lack integration and interaction with formal education, and even has a certain degree of disconnection. Exhibition resources cannot be excavated deep since visiting exhibitions is always taken as an educational means to improve students' comprehensive quality. Moreover,

the importance of museum education in the parts like university teaching and scientific research has been ignored for a long term, so its active participation lacks.

(2) The effect of university museum education requires to be polished. Museum visiting merely rests on physical observation and one-way explanation as acknowledged by the public (Fan *et al.*, 2018), most of which are short in interactive communication and design for objectives to cater to the needs of course education. There is a far distance between normal museum visiting activities and curriculum-targeted education, where the need of personalized learning and knowledge system cognition is not appreciated. In another word, students are always taken to the museum aimlessly, and seldom gain information in-depth.

(3) Generally speaking, the educational methods of university museums are relatively casual and lack the guidance and norms of educational theory.

To solve the above problems, it is necessary to form a pattern of organic combination, mutual promotion and coordinated development between museum education and university education, so as to realise the core values of museums and broaden their own development space. University museums should actively use effective new educational means and deeply embed themselves in university teaching and scientific research activities. However, in reality, there are few relevant theoretical research results on how to promote the organic combination of museum education and university education and effectively realise the mission of cultivating talents.

As demonstrated in the paper, a new pattern "flipped museum" is supposed to be introduced in museum education. To prove the demonstration, the authors take concept interpretation, literature research and case studies with the aim of solving the problems commonly faced by the current university museum education and making the museum education closer to higher education, along with better educational effects of museum exhibitions played. The fundamental goal is to discuss and sum up several universal rules in "flipped museum" pattern that can be applied in general university museum education.

ABOUT THE "FLIPPED MUSEUM" PATTERN

From "Flipped Classroom" to "Flipped Museum"

The concept of "flipped museum" originates from a pedagogical term "flipped classroom" which popped up in recent years along with online education. In the early 1990s, Eric

Mazur, a professor of physics at Harvard University, carried out early research on the flipped classroom (Mazur, 1991). He summarised learning into two processes: knowledge transmission and knowledge internalisation[1] (Mazur, 1991). "Flipped classroom" is to reverse the two processes and change the order between in and out of class.

When the educational concept of "flipped classroom" is applied to museums, that is, when museum education is embedded into classroom teaching as a "knowledge internalisation" process, the blended learning method can be called "flipped museum".

Literature Review

As literature retrieval shows, there is a paucity of literature that explicitly uses the phrase "flipped museum", proving that it is still a new concept in the museum field. With the deepening application of "flipped classroom", museum education gradually adopts the approach since 2010s. The Royal Coin Cabinet, National Museum of Economy in Sweden introduced the concept of "flipped museum" and experimentally launched a project in 2014, regarding the curriculum of local primary and secondary schools (Von Heijne, 2014). The project aims to improve students' entrepreneurial spirit through students' independent learning of film materials provided by the museum in advance, group discussion, and research (Von Heijne, 2014). Coincidentally, in 2015, Michelle H. Harrell and Emily Kotecki, two scholars from the North Carolina Museum of Art, proposed the issue of "what is a flipped museum" and carried out a pilot project for teenagers, inverted the delivery and application of knowledge in a museum setting (Harrell and Kotecki, 2015). Afterward, the fresh education pattern, "flipped museum" has been increasingly used in practice. "Flipped museum" was taken as a case study on the school-museum collaborative learning model in the digital age by Korean scholar Inae Kang, Jin-hye Jang, Ming-yeong Gu in 2017 (Kang, *et al.*, 2017). In addition, scholars such as Young-min Park (Park *et al.*, 2018) and Hye-won Shin (Shin *et al.*, 2018) from Korea, Mette Fredslund Andersen (Andersen *et al.*, 2020) from U.S., and Luwei Fan, Ying Hu from China respectively have made practical exploration and case studies on the museum application of "flipped learning" and "flipped classroom" (Fan *et al.*, 2018, Hu, 2018).

Since the concept of "flipped" was put forward in pedagogy, it has continuously penetrated and evolved in various fields and scenes. The museum studied in the paper has shown more possibilities in practice for its own properties and the "flipped" pattern also provides new idea for the further development of museum public education.

[1] Knowledge internalisation refers to the learners' learning, communicating, sharing, accepting, and digesting the new knowledge, which makes it integrate with the learner's inner knowledge, including knowledge category, literacy, ability and so on (Deng, 2020).

RESEARCH METHOD

This paper used qualitative descriptive case study methodology as the main research method, under the theory frame of "flipped classroom", aiming to make an empirical study on the "flipped museum" education pattern. Inherent museum education pattern is expected to be broken by the application of "flipped museum", as well as realising the deep integration of university museums and university course teaching that students' interaction and thinking can be improved in class. Accordingly, the quality and effect of higher education is further enhanced, which highlights the educational function of university museum as well.

Four "flipped museum" educational activities embedded in courses planned and held by Tsinghua University Science Museum in 2021 are selected as research cases. Using the inductive method, this paper studied the implementation pattern, basic characteristics and the significance of the "flipped Museum". Qualitative evaluation of teaching effect is carried out through observation and feedback from teachers and students.

CASE STUDY

Research Site

Tsinghua University Science Museum, in development, is the first comprehensive science museum devoted to scientific collections in China hosted by China Comprehensive University, working in conjunction with the Department of the History of Science in Tsinghua University. It presents scientific objects and high-tech interactive exhibitions to reproduce the great scientific discoveries and technological inventions in the history of science and technology, as well as the brilliant science and engineering achievements of Tsinghua University in modern China. The museum devotes itself to promoting science communication and stimulating scientific and technological innovation. The construction of the permanent museum will start at the end of 2022, adjacent to the Art Museum of Tsinghua University.

After four years of preparation, the temporary exhibition halls of the museum opened to the public with all the essential functions equipped, including research, collection, exhibition, visiting services, public education, media communications, digitisation, etc. At present, the Science Museum owns more than 6,000 collections and has successfully held several scientific exhibitions, such as *"A Century of Instruments:*

The Collection of Historical Scientific Instruments of Tsinghua University

"Maneuvering Numbers: The Calculating Device in the Past and Present" and "To Soar into the Sky: The Flying and Engineering Machines of Leonardo da Vinci", etc. All exhibitions are digitalised for online access, which is available all world around.

The Museum actively held a variety of public education activities and has constantly been introducing new educational ideas. In 2021, 28 public educational activities were successfully held, including several practical cases of "flipped museum".

Figure 1: Tsinghua University Science Museum Permanent Building Simulated Diagram. (Source:?)

Figure 2: Exhibitions held by Tsinghua University Science Museum. (Source:?)

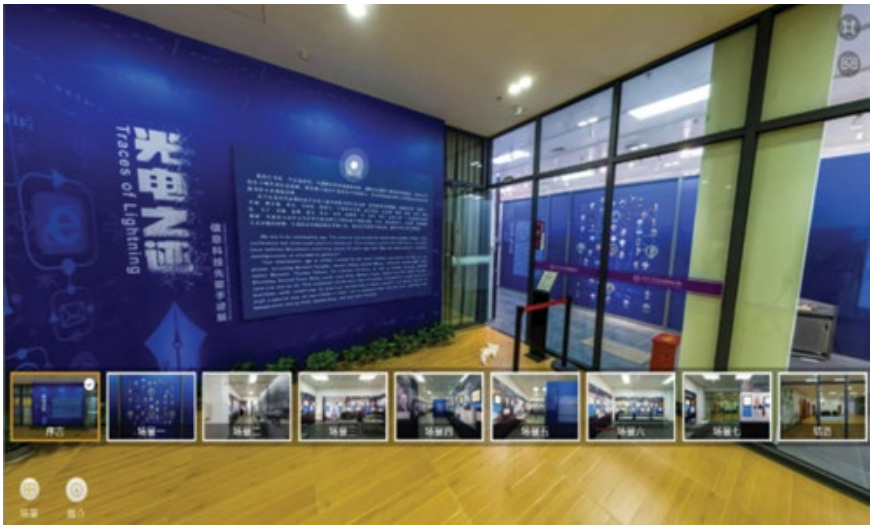

Figure 3: Digital exhibition (both English and Chinese version). (Source:?)

Figure 4: Educational activities conducted by the museum. (Source:?)

Case Studies on "Flipped Museum" Practices in Teaching and Discussing Conducted by Tsinghua University Science Museum

Regular museum visits are usually regarded as an informal educational means for students to expand their knowledge, which is arranged before or after class to complement with classroom teaching. Tsinghua University Science Museum tried the "flipped museum" pattern, where students learn the knowledge points of the

course before class and use classroom time for museum exhibition visits and study, supplemented by professional explanation or discussion combined with the course. Thus, the bridge between the museum and university teaching and scientific research activities has preliminarily been set up, especially the connection between the exhibition and the course content, improving the learning effect.

In 2021, Tsinghua University Science Museum carried out several museum educational activities embedded in course teaching jointly planned and implemented by professors from departments and museum staff. Four distinctive cases of "flipped museum" are picked to conduct the study.

Establishing Content Associations between Exhibitions and Courses

The following are two teaching cases of "flipped museum" differing in course types, learning objectives, and exhibition contents, but both take the museum learning link as the classroom teaching content and carry out "knowledge internalisation". The museum has made innovative attempts to embed exhibitions in the course teaching.

Case 1: The Artistic Practice Class of *Inspiration from Arts* Curriculum

Inspiration from Arts is a general education course offered by the Academy of Arts and Design of Tsinghua University, with 47 undergraduates from Xinya College participating in the study. Two artistic practice classes were arranged in the Science Museum, focusing on the exhibition *"To Soar into The Sky: The Flying and Engineering Machines of Leonardo da Vinci"*, designed to build a student development mechanism with the integration and interaction of science and arts. Relying on scientific exhibitions and focusing on aesthetic education, the general education function of scientific exhibitions has been brought into full play in the class.

The first class was in the multi-functional conference room of the Science Museum. In the first half of the course, the museum staff gave a micro-workshop on scientific and aesthetic education introducing the life and spirit of Leonardo da Vinci, and deeply explained the exhibition. From the aspects of the origin, the idea and the meaning of the exhibition. Then, based on the staff's speech, the keynote Professor Mu Li put forward thinking problems and expectations to the students in the context of

the course, guiding students to jump out of the isolated thinking of the separation of traditional science and arts. As Li insisted, it is supposed to look at the world from the combination of the two, establish a private spiritual space and become a "new person" different from the previous era.

Whereafter, students visited the exhibition freely in the exhibition hall. Some of them depicted scientific exhibits with paper and pen, some meditated, writing down their learning experience. Students' works will be submitted as course assignments.

Figure 5: The Artistic Practice Class of *Inspiration from Arts* Curriculum in Tsinghua University Science Museum. (Source:?)

Case 2: The Media Practice Class of the *Media History* Curriculum

Media History is a professional elective course for postgraduates offered by the school of Journalism and Communication, with 40 master students involved. Two media practice classes were in the Science Museum. The target is to enhance students' understanding of media technology development and find solutions to solve problems brought by new media technology.

The first class was an exhibition visit. Under the guidance of the museum staff, the students learned the exhibition *"Traces of Lighting: Handwriting of Pioneers in Information Science and Technology"*. By more than 40 precious manuscripts of information technology pioneers, the history of media technologies from electromagnetism, telegraph, telephone, fax, radio, television to computer, internet and mobile communication was restored, vividly telling the social development behind them.

The second class is an interactive discussion. The students exchanged views on academic issues such as "which section of the history of media development from light to

electricity has the greatest impact on human society" and "how handwriting, as an important way of human writing, shapes human subjectivity". Jingwei Wu, the professor of the course, and Hao Cheng, the exhibition curator, commented from the perspective of the course and exhibition, analysing the role of electronic media and information technology in reshaping the relationship between people and society. Enlightening questions were put forward.

Figure 6: The Media Practice Class of *Media History* Curriculum in Tsinghua University Science Museum. (Source:?)

Case Studies on "Flipped Museum" Practices in Exhibition-centered Course Seminars

The following two seminar cases of "flipped museum" mainly focused on helping students internalise knowledge and think deeply in an interactive way. Seminars in different fields were held in the Science Museum, and discussions were based on exhibitions. Both faculty and museum staff jointly designed and implemented the activity. In case 3, the museum and the department planned the collection of students' design works together. Case 4 stimulated students' initial innovation enthusiasm with the deeds of scientific and technological pioneers via the museum exhibition.

Case 3: Teaching Achievement Exchange of *Architectural Design Masterclass*

Architectural Design Masterclass is a practical course cooperated by the School of Architecture of Tsinghua University and famous professional architects who served as

course tutors. The School of Architecture and the Science Museum jointly planned an open exhibition, *"Teaching Achievements of Designing Liang Sicheng Memorial Pavilion in Jinchun Garden"*. The creative design works of 11 students were displayed to the public, including renderings, technical drawings and solid models.

As a summary of the course, the "sharing and exchange meeting on the design and teaching outcomes of Liang Sicheng Memorial Pavilion in Jinchun Garden" was held in the Science Museum. Course-related teachers, students, museum members and the audience attended.

The activity was carried out in the form of micro-lecture, viewing and exchange. Firstly, the tutor gave a micro-lecture to summarise the teaching achievements of the course. Then students freely exchanged their research and design experience. The museum members and audience expressed their feelings as well. The second part is the design work observation and exchange. The tutor commented on the on-site works and discussed with students. The seminar aims to provide a platform for students to share academic achievements and promote the interdisciplinary integration of scientific, historical research, and architectural design practice.

Figure 7: The Sharing and Exchange Meeting on the Design and Teaching Outcomes of Liang Sicheng Memorial Pavilion in Jinchun Garden held in Tsinghua University Science Museum. (Source:?)

Case 4: The Seminar on *Electromagnetic Information Theory: The Centennial Appointment from Shannon to Maxwell*

With the rapid development of communication technology, the channel capacity is touching the ceiling of communication theory. The seminar on *"Electromagnetic Information Theory: Centennial Appointment from Shannon to Maxwell"* was held by

the Department of Electronic Engineering of Tsinghua University in the Science Museum. The seminar theme was closely related to the exhibition "*Traces of Lighting: Handwriting of Pioneers in Information Science and Technology*". It was a small internal academic activity aiming to encourage and inspire students to seek new directions of telecommunication theory, attended by 14 students, two professors and museum staff.

There are two sessions: visiting the exhibition guided by museum staff and having an academic discussion. In the discussion, students reported the research ideas of the cross-study on electromagnetism and information theory, and the supervisors gave instructions. Afterward, a fruitful brainstorm followed.

Figure 8: The Seminar on *Electromagnetic Information Theory: Centennial Appointment from Shannon to Maxwell* in Tsinghua University Science Museum. (Source:?)

Feedback on the Cases

The four "flipped museum" cases have received positive feedback from the teachers and students of the departments jointly conducting the activities with the Museum. The feedback collected by museum staff from students' after-class assignments and emails from teachers forms the non-quantitative evaluation of teaching effectiveness. As the feedback reveals, teachers were satisfied with the "flipped museum" pattern due to the creative class practices in the Museum, looking forward to continuing cooperation with the Museum in the future.

According to Jingwei Wu, the teacher of the *Media History* curriculum, the courses combining exhibition practices bridge the gap between academic research and public education.

It is grateful to the Museum staff's thoughtful arrangement of the class, which received unanimous praise from students. Everyone likes this way of class. Classroom interaction is also very good. Integrating Museum historical resources into teaching and research is just a good bridge between academia and the Museum.

Moreover, it is demonstrated by Linglong Dai, the associate professor of the Department of Electronic Engineering, that the seminar on *Electromagnetic Information Theory: Centennial Appointment from Shannon to Maxwell* is of significance to the development of Electromagnetic Information Theory.

Thanks to the seminar, the students actively spoke and boldly put forward the cross innovative ideas of electromagnetic field theory and communication theory, which scarce in daily seminars and classes. The collision of views provided new vitality for subsequent scientific research. It is the first symposium on electromagnetic information theory held in China, which is quite meaningful both to the related fields and to those who devote themselves to the area.

As well acknowledged among students, the "flipped classroom" in the Museum enables them to deepen their understanding of curriculum knowledge and expand the scope of information. It is the sense of immersion brought by the exhibitions that struck them in depth, which is seldom available in normal classes. Peizhuang Miao, the master graduate of the School of Journalism and Communication, attending the Media Practice class of the Media History curriculum, illustrated his ideas based on the relationship between the exhibition and the development of media.

When walking in the exhibition hall, a sense of scene struck me, which is quite different from textbooks and traditional classrooms, arousing my interest in the history of photo electricity. However, as far as the knowledge category involved in the exhibition is concerned, it lacks a discussion on the relationship between media and people and the deeper meaning of media, which restricts the further transmission of the exhibition information. The intertextuality inside the class on the basis of the Exhibition inspires me to explore the deeper relationship between information capacity and media development.

DISCUSSIONS AND FINDINGS

Similarities and differences exist in the above cases. Case 1 and case 2 focus on promoting course learning, where students are taken as the ones actively learning, accepting and applying information. Through interpretation, feedback, and observational activities, students can establish interdisciplinary interaction with teachers. The interaction between the two sides is also based on the museum's physical space and specific situation, which jumps out of the simple communication with language as the medium and makes up for the shortcomings in the process of knowledge transmission. Through their subjective initiative, students look for the "relevance" with their course content in the environment established by the Science Museum and find a fulcrum in the deepening of essential discipline learning and innovation.

When it comes to case 3 and case 4, the Science Museum closely combines the museum's public education with specialised academic education through demassification education, focusing on further content of the course by the means of seminars (Von Heijne, 2014). Despite it is still serious to visit museums in the public consciousness, it is difficult for many teachers to take time to visit museums merely "for fun". The visit to the museum is oriented towards activities, group dynamics, discussion and problem-solving (Von Heijne, 2014). Therefore, the two cases highlight the key points of the integration of "flipped museum" and high education-high degree of professionalism. Both teachers who host curriculum and museum staff involved in planning activities are required to have abundant knowledge reserves.

The Basic Characteristics of the "Flipped Museum" Pattern

As the cases show, despite there being no fixed format to follow, same as the flipped classroom, essential characteristics and core elements of the flipped museum can be summarized based on practices. The flipped museum's basic framework is extracted in Table 1 according to six key elements. From the perspective of the space-time dimension, the museum learning time turns from extracurricular to class, and the place of class shifts to the museum so that the university museum moves towards the home field of teaching. As to the classroom learning content, the traditional indoctrination of information transmission is turned into knowledge internalisation, including exhibition learning, micro-lectures, communication, and interaction between teachers and students. Therewith, students change from passive receiving information to active learning and personalized[2] learning (Zhang *et al*., 2017). The corresponding course design directly determines the learning

[2] *As Zhang illustrates, with the development of flipped pattern, diverse choices of learning means are flexibly available to students (Zhang et al, 2017).*

effect of the flipped museum. Museum staff and course teachers jointly design the course content and both of whom also play the role of learning instructors. In the flipped museum pattern, museums and departments, museum staff and teachers are acting as partners.

Information technology provides more online educational resources and teacher-student interaction for flipped classrooms and museums in the digital age.

Just as in the "flipped classroom" pattern, students can learn independently through video lectures, Massive Open Online Courses (MOOCs) and other ways before class, meanwhile, more precious class time is available for enhancing exchanges and discussions between teachers and students to jointly construct the knowledge system, the time management in "flipped museum" pattern is more flexible to learners, opting to supplement knowledge related to the course or watch museum-relevant materials online before and after class. However, the basic definition of a flipped museum cannot be confined to the use of new technological means. The essence lies in that the allocation of time and content inside and outside the class has been reversed. Thus, the term "flipped museum" in the paper is discussed in a broader sense, that a successful flipped project relies on the rational distribution of learning time in and out of class time and resources provided by museums, rather than merely applying sharp technologies.

Table 1: The Basic Characteristics of the "Flipped Museum" Pattern.

Core Elements	Conventional	Flipped
Where	Classrooms	Museums
When	After school hours	During class time
How	Knowledge transmission	Knowledge internalization (including museum learning)
Students	Passive	Actively experience, exchange and interact, inspired to innovate and deepen what they learn
Teachers (Tutors)	Lecturers	Learning instructors, course co-designers
Museum Staff	Guides	Learning instructors, course co-designers

The Significance of Introducing the "Flipped Museum" Pattern

As a more flexible and active learning method, the "flipped museum" pattern breaks the inherent space-time, process, and structure of museum visits and learning. It is an important transformation of the educational paradigm with ample innovative space for new ideas of museum education. There is a saying, "Tell me, and I will forget; show me, and I may remember; involve me, and I can learn". It reveals the truth that there is no necessary connection between teachers' complete and efficient output of knowledge and students' absolute mastery of it (Yu, 2015). Learning concepts, teaching concepts, different subject

backgrounds, and different teaching situations will complicate the cognitive theory between learners and teachers and differentiate between traditional students' learning and academic teaching (Knewstubb, 2016). The advantages of physical display, participation and interaction of university museums greatly benefit students' in-depth understanding of knowledge.

In museums' traditional extracurricular visiting activities, students often skim the surface and cannot grasp the key points while the commentators merely concern the exhibition itself, out of touch with the course. The "flipped museum" pattern overcomes such weaknesses, making students' visits more targeted, more involved, more enthusiastic and more efficient, and adding value to the educational resources of the museum as well.

In addition, the "flipped museum" pattern also helps to establish the partnership between university museums and academic departments, deeply embedded in teaching and research.

CONCLUSION

A Perfect Concerto of Informal and Formal Education

For a long time, museum education merely acted as an extracurricular supplement to the formal education of the school system since it was widely regarded as informal education (Ying, 2018). While the United States proposed that informal education, higher education, and k12 education should be taken as one of the inseparable subjects of the education system as early as 2007 (Song, 2020). "Flipped museum" pattern is the crystal of collaboration between the university museum and the university teaching and scientific research system, constructing a better-blended learning environment for students.

It can be seen from the above cases that in the "flipped museum" pattern the class venue and time are shifted to the museum, and the museum staff is deeply engaged. Museum education has become an essential part of course teaching, and museum resources can be fully exploited. It increases the interaction and experience of the museum, making the teaching process more exciting and effectively helping students deepen their knowledge.

Applied within Certain Scopes

"Flipped museum" has no fixed format but has the scope of application. The general education courses, practical courses, design courses and interdisciplinary courses

in the above cases are the helpful directions of museum education, suitable for combination with exhibitions. Exhibitions with course-related themes can help students understand the history of discipline development, observe and appreciate the structural form of exhibits, inspire in-depth thinking, stimulate creative inspiration, and promote interdisciplinary integration vividly and intuitively.

University museums ought to plan and present more high-quality exhibitions that match the diverse discipline characteristics of the university. In addition, understanding the university's curriculum and teaching objectives is vital to choose the appropriate combination points to integrate into the suitable courses. Moreover, it is supposed to attract the attention of relevant course teachers and jointly promote flipped education in the museum to achieve win-win results.

A New Challenging Role for Museum Staff

The classroom content carefully designed by museum staff and teachers is the key to making students more active, interactive during the museum learning process. "Flipped museum" is inseparable from exhibition explanation and guidance interaction. It is a good choice for museum staff to explain the exhibition or give micro-lectures in combination with the relevant course and for faculty teachers or curators to communicate and interact with students in the discussion sessions.

Compared with the regular museum visiting activities, museum staff plays a more challenging role in the "flipped museum" pattern. They are involved in planning activities, giving lectures and also act as an "exhibition guide" for students. The blended role requires museum staff to have outstanding professional ability and abundant knowledge reserve, be familiar with teaching objectives and find intersections between the course and the exhibition. In addition, they are also required to master the dynamic feedback of students so as to adjust content accordingly to provide personalised interaction.

Further Theoretical and Empirical Research Required

Today, "flipped museum" is still a new concept that remains in evolution and development for museum education. There are no accepted standard principles or definitions for the new educational pattern, so it needs to be examined, studied and practiced with a scientific attitude, especially in quantitative research. The course design scheme of the

"flipped museum" pattern needs to be further accumulated in practice, and the teaching effect also calls for empirical evaluation. The way to bridge students and museums varies, as the cases illustrate above, the technology method is not the only optimal solution. "flipped museum", with strong time-space attribute and interaction properties, has its pedagogical meaning and vitality. Ultimately, man is the main body of the flipped museum practice. Thus, flipped education in museums can be regarded as the embodiment of teaching students according to their aptitude and the content of the course.

The introduction and development of "flipped museum" reflects a reform idea, which pursues the combination of museum education and school teaching and the effectiveness of education. It is believed that this new educational pattern will bring vitality to the university museums and become the development trend in the future.

ACKNOWLEDGEMENTS

The study was supported by Tsinghua University Science Museum. Its conclusions partly rely on diverse educational experiences and ongoing work under different disciplinary backgrounds undertaken jointly by the Museum and various colleges and departments of Tsinghua University. The "flipped museum" cases would not have been possible without the cooperation of the professors who engaged their teaching in the Museum. We are particularly grateful to Professor Mu Li from Academy of Arts and Design, Professor Xingang Li and Professor Li Zhang from School of Architecture, Associate Professor Jingwei Wu from School of Journalism and Communication and Associate Professor Linglong Dai from Electronic Engineering Department.

The paper was presented at the 2022 AUA Academic Conference on Co-Curating Flipped Museums for Asian Civilization: A Blended Research and Teaching Approach. Many thanks to the conference sponsors and organizers for providing the opportunity of deep discussions on flipped education attempts by university museums. We also thank the many museum colleagues and volunteers who have contributed to the museum education activities in Tsinghua University Science Museum.

AUTHOR CONTRIBUTIONS

Aihong Fan, the lead author, proposed the core point of the paper, conducted the case studies, wrote the Chinese manuscript, and reviewed the translation. Zihe Xia, the second author, duty for collating, supplementing and translating the Chinese manuscript in English. Ling Yin, the third author, assisted in the implementation of practical cases.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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