Science Teachers’ Development of Museum-Based STS Modules-What Do Their Perceptions and Practices Tell Us?

CHI-CHIN CHIN

Graduate Institute of Education and Center Of Teacher Education, Tunghai University, Taiwan, R.O.C.

(Received August 12, 1999; Accepted April 12, 2000)

Abstract

In this study two teachers were invited, an elementary science teacher (Mr. Long) and a secondary biology teacher (Ms. Mei), to become involved in a development process of museum-based science-technology-society (STS) modules. Through the process, the author attempted to understand the teachers’ perceptions and practices, and obtain advice for teacher educators to improve teachers’ abilities in using social resources. Qualitative methods were used to collect the data throughout the module-developing process, and narratives were written to analyze the data. The results showed: (1) Two teachers had quite different prior knowledge of STS and expectations to this project. (2) As a secondary school teacher, Ms. Mei was more inclined to obtain conceptual information rather than the pedagogical strategies. (3) Neither teacher really understood the role technological issues played in the STS modules. (4) They used various methods to teach but cover too much materials in their STS modules. (5) Mr. Long agreed that this project was helpful in improving his teaching skills through understanding the rationale of STS module; on the contrary, Ms. Mei, restrained by educational goals set at the secondary level, did not think museum-based STS modules, even general ones, were useful. In summary, the results implied that teachers had difficulty developing museum-based STS modules. The museum setting seemed to be an alien world for these teachers. Here, the author suggests the difficulty might be overcome through two approaches: (1) The improvement of teachers’ understanding of STS, including both its rationale and strategies, and (2) the enhancement of teachers’ knowledge about informal educational settings. Moreover, the gap between formal and informal education should be eliminated. Since the infusion of social resources in science teaching requires an integration capability, teacher education programs are believed to be one of the fundamental and effective channels to eliminate this gap.

Key Words: In-service teacher, Museum education, Science teacher, Science-technology-society(STS), Teachers’ beliefs

I. Objectives of The Study

In Western countries, informal learning settings have been used for decades for developing educational activities (ASTC Newsletter, 1994; Bitgood, 1988; Crane, Nicholson, Chen, & Bitgood, 1994; Drake, 1992; Finson & Enochs, 1987; Igoe, 1993). Tamir (1983) reported that the effectiveness of children’s learning of science was facilitated if teachers led extensive field trips to environments such as science museums, botanical gardens, zoos, and planetariums after school science lessons were given. Others (Oslund, Gennaro, & Dobbert, 1985; Galbraith, 1990) also indicated that the students’ learning could be enhanced significantly if the visits to informal settings were organized systematically. Therefore, the issue of how to help teachers effectively use museum resources to teach school science lessons has been studied (Chin, 1995a; Hodgson, 1986; Szpakowski, 1973).

In general, teachers obtain benefits from using museum-oriented resources in two ways: The first is that the teacher can be empowered in terms of his or her professional ability in teaching science (Finkelstein, Stearn, & Hatcher, 1985; Bedworth,
The utilization of museum resources to facilitate the learning among school children is a brand new issue in Taiwan. The limited amount of existing information suggested that teacher’s improved understanding of the nature of informal settings (Forber, 1993). If teachers’ professional ability to use museum resources is improved successfully, their instruction in the museum context is expected to be more meaningful for students. In addition, through teacher’s curriculum design, the role of informal settings and the opportunities inherent in such environments will be introduced to our future citizens.

The utilization of museum resources to facilitate the learning among school children is a brand new issue in Taiwan. The limited amount of existing information suggested that teacher’s understanding of museum education remains inadequate in Taiwan (Chin, 1995a), even though there is a strong desire to learn about museum resources and strategies for utilizing these materials (Huang, 1992; Liu, 1989). Most Taiwanese teachers visit science museums mainly to fulfill objectives in the cognitive domain and simply use science museums as supplementary resources for preparing additional activities to extend school science lessons (Chin, 1995b). Visits are perceived as a tool for enhancing students’ knowledge of scientific concepts.

Here, we argue that teachers should not neglect learning opportunities they can offer in informal settings. The quality of visit undoubtedly depends on the capabilities of the teachers prepared to give the instruction in the science museum. In short, the teachers should be eligible to enrich their teaching using the social resources in the future. School lessons should not be confined in the traditional classroom. Moreover, the teaching materials should not be developed merely for being used indoors. Under such circumstances, new dimensions of teachers’ professional abilities should be taken into account and nurtured during teacher education programs (Chin & Tuan, 1999, 2000). However, before teacher educators do this, there first needs communication about what teachers will face and perceive while they turn museum resources into science lessons. Therefore, this study established a process for teachers to become actively involved in developing museum-based STS modules. What happened to teachers throughout the development process was investigated and their stories were represented as narratives. In summary, the author investigated the following aspects through the process:

1. Teachers: Mr. Long and Ms. Mei

Mr. Long is a 55-year-old elementary school teacher. He obtained his elementary school teaching certificate after completing the program offered by a teachers’ preparation school almost 35 years ago. Mr. Long afterwards continued to attend in-service courses in a teacher education program in pursuit of a junior college diploma. Mr. Long teaches science courses in the fifth grade of an urban elementary school and serves as a coordinator for academic affairs at that school. Since he emphasizes learning science through real experience, Mr. Long often organizes field trips for his students, colleagues, and students’ parents. He frequently uses museum resources to enrich his teaching of science. He also acts as a seed teacher to assist the curators’ educational development.

Ms. Mei is a biology teacher at a secondary school system. Although informal settings were recommended as one of the choices for implementing STS teaching, none of the studies focused on the issue of how Taiwanese teachers performed in a museum setting. Therefore, this study was thus the first to examine teachers’ development of STS module and their practices within museum settings. The findings would enable teacher educators and museum curators to collaborate together in developing suitable program for teacher empowerment.

II. Research Designs

This three-phase, seven-month project followed an elementary, Mr. Long, and a secondary school teacher, Ms. Mei, as they developed STS modules based on the museum resources. Qualitative methods were used throughout the process to collect in-depth data. The author met with the teachers two or three times a month to discuss the project and provide the necessary supports. Throughout the study, records of discussions, interviews, observation of practice teaching, and preliminary and revised modules were collected.

1. Teachers: Mr. Long and Ms. Mei

Mr. Long is a 55-year-old elementary school teacher. He obtained his elementary school teaching certificate after completing the program offered by a teachers’ preparation school almost 35 years ago. Mr. Long afterwards continued to attend in-service courses in a teacher education program in pursuit of a junior college diploma. Mr. Long teaches science courses in the fifth grade of an urban elementary school and serves as a coordinator for academic affairs at that school. Since he emphasize learning science through real experience, Mr. Long often organizes field trips for his students, colleagues, and students’ parents. He frequently uses museum resources to enrich his teaching of science. He also acts as a seed teacher to assist the curators’ educational development.

Ms. Mei is a biology teacher at a secondary
school level. She graduated from a normal university and has obtained a master's degree in science education. She possesses 14 years of teaching experiences. Similar to Mr. Long, Ms. Mei has experience as a docent in a science museum.

2. Research Procedure

This study consisted of three phases. The author met with the teachers two or three times a month to discuss and clarify their questions, and also to provide context for expressing their relevant experiences. During the first phase, STS concept and an example STS module were introduced. The second phase focused on in-depth discussion for generating ideas. During this phase, the teachers proposed possible topics and shared their ideas about the infusion of societal and technological issues, major scientific concepts to be conveyed, and their connections to museum resources. The teachers were then requested to collect relevant resources to match the topics. The teachers finally achieved a consensus to adopt water as the issue for the development of STS modules in the following phase.

The specific topics chosen by Ms. Mei and Mr. Long were “the importance of water resources” and “water contamination”, respectively. After their preliminary modules were submitted for peer review for further revisions, the revised forms were practiced in real museum settings. Their practice periods were recorded on videotape; then presented at meetings to facilitate self-reflection and obtain peers’ comments. Based on the feedback, the teachers refined the modules as much as possible. Throughout the study, records of discussions, interviews, practice teaching, and preliminary and revised modules were collected. Interviews were conducted at the following times: 1) before the teachers began the study, 2) after the example STS modules were presented, 3) after they designed the preliminary modules, 4) after they completed the practice sessions in the science museum, and 5) after reflection based on video-records. In addition, there were also informal interviews.

3. Narrative Analysis

Along with data collection, the author wrote narratives. Narrative analysis is based on the belief that what is expressed in stories, explanations, and discourses are representations of experiences rather than social reality (Riessman, 1993). The words used are no longer looked as objective and value-free. Five stages for dealing with the experience-participating in the experience, telling the experience, transcribing the experience, analyzing the experience, and reading the experience—were used to explain the relationship between the researcher and the representation of the experience. Based on such a rationale, narrative analysis was not used mainly for informing social reality. Instead, life stories and discourses were regarded as means of expression. In writing the narratives, data from various sources was organized and presented according to the teachers’ construction of reality. In other words, the author focused on how the two teachers grasped, presented, and explained their experience in writing the narratives. The narratives showed how they used words to persuade others. In this paper, the author describes the research context as much as possible to help readers judge the relation to the reported findings.

III. Findings

Since this study gave the teachers a process for engaging in the development of museum-based STS modules, the findings were therefore validated by the increased information gathered through the process. The significant findings of the study are shown below according to the time sequence of the process:

1. Phase I

A. From the discussions, both teachers showed different prior knowledge of STS, and different expectations to the project.

STS concepts and an example STS module were introduced in the first phase of the study. Through the interactions, the author discovered more about the backgrounds of two teachers in STS education.

In the first two discussion sessions, Mr. Long did not actively tell us what his perception of STS was. He just sat quietly and listened to my explanation and what was being discussed. His silence prompted me to invite him to join the interaction. He responded honestly: “I have never heard of STS before.” However, he expressed his appreciation on the opportunity for empowerment. He said: “I like to learn new things. By cooperating with curators and other colleagues at the science museum, I hope to learn some new ideas and strategies, which will benefit my teaching of science.” (Narrative 960921)

In general, in-service training and workshops were a key means for Mr. Long to keep abreast of the educational trends. He felt everything new to him was worth learning. Actually, the discussions relevant to STS education were alien to Mr. Long, but he thought active involvement was the best way to learn some-
Mr. Long did not really understand what STS was. When I asked him to describe what he had learned from the first meeting, he replied: “I guess STS must be a teaching strategy beneficial for improving the teaching of science. From your explanation and the supplementary materials you provided, a picture that STS teaching must be filled with interaction between teacher and learners emerged in my mind. I believe it could help teachers create a genial learning environment.” Although he did not describe the real spirit embedded inside STS teaching, he at least recognized the possible effectiveness of STS if it was used in his teaching. (Narrative 960930)

Another teacher, Ms. Mei, had a quite different predisposition for attending this project. The following narratives will help readers to judge her understanding of STS.

With double majors in biology and science education, Ms. Mei was more acquainted with recent educational theories and strategies. For instance, Ms. Mei had learned many specific terms used in science education, including STS. Therefore, in the first group meeting, she could relate the definition of STS to us in a generalized way: “STS is a kind of strategy used in the teaching of science. Science teachers adopt a certain societal issue related to students’ daily experiences to make science concepts more easily understood by the students.” From her discourse, societal issues obviously played major roles in the way she defined STS teaching; however, I wondered why she merely mentioned societal issue, but technological issues were not indicated. I asked her: “What aspects would you like to learn through this project?” Ms. Mei replied: “I am interested in novel STS issues. I would like to obtain more relevant information about STS issues.” (Narrative 960921)

At the very beginning of this project, Ms. Mei noted that the societal issues were the core element in STS teaching, but Mr. Long did not know this basic idea. However, even though Ms. Mei said that societal issue had an indispensable role in the STS module, she did not mentioned how to adopt technological issues in teaching science.

B. From the discussion, Ms. Mei showed misconceptions about science-technology-environment-society (STES) and science-technology-society (STS).

In spite of strong background in science, Ms. Mei failed to explain the relationship between the scope of “ecology” and “environmental science”. Such kinds of misunderstandings apparently influenced the issues that Ms. Mei chose for developing STS module. For instance:

While discussing whether environmental issues were suitable for STS-oriented teaching or not, Ms. Mei disclosed her confusion about STS and STES. She said: “The first ‘S’ is the abbreviation for the word ‘science’. Therefore the development of an STS module should be characterized as a process using the societal issues to introduce general scientific concepts. ... I have also heard of the term “STES”. The letter “E” here represents environmental issues in society. In my view, environmental issues and societal issues are quite different concepts. If environmental issues are used, the purpose of the module will be to help children understand ecological concepts in the area of biology... It should not be used to explain environmental problems or environmental science.” I was really confused by her explanation and it took me quite a long time to understand what she meant. I tried to draw a table (Shown in Table 1) to represent her words in a simple way and finally figure out what was wrong with her conceptual framework.

<table>
<thead>
<tr>
<th>E-S_1</th>
<th>S_1TS_2</th>
<th>S_1TES_2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Societal issues</td>
<td>General scientific concepts</td>
<td>Environmental issues/problems</td>
</tr>
</tbody>
</table>

She regarded the environmental issue being solely used in a STES module for explaining the relevant ecological concepts. Ms. Mei claimed: “I would follow the definition, and not present environmental issues in so-called STS modules.” (Narrative 961019)

According to the narratives, we know Ms. Mei did not really understand the differences between the definitions of STS and STES. She misinterpreted the scope of science projected from the STS and STES issues, respectively.

The first phase lasted for one month. During this phase, we found teachers’ prior knowledge of STS and their perceptions of societal and technological issues played an important role in the STS modules. In addition, although Ms. Mei had acquired information about this field before, confusion was found in the relevant conceptual framework.

After the rationale of STS teaching was introduced, the discussion in the following phase was oriented to find the suitable issues for further developmental work.

2. Phase II

A. Ms. Mei disclosed her inclination to obtaining conceptual information rather than the pedagogical strategies.

This phase featured in-depth interactions for the purpose of seeking issues that could be employed in the subsequent development process.

During the discussion period of this phase, I requested Ms. Mei and Mr. Long propose possible topics first. Then, based on the issues they could share their ideas about how societal and technological issues were infused, the major scientific concepts included, and connection to museum resources. The notable issues suggested by them included energy, evolution, time, and water. Ms. Mei once complained the topics discussed during the meetings were too easy. She said: “Most of the STS topics we discussed were those I already know. I appreciate the way Dr. Chin led the meetings. Actually, there were some strategies I could learn to use as a discussion leader. However, I
Museum-based STS module developed by science teacher

Scaffolding complete forms in the future. Their paper-Mr. Long were requested first to design guidelines for phase. Thereafter, Ms. Mei and Mr. Long agreed to adopt the significance between possible topics were compared. STS modules. In the meantime, the feasibility and the information independently for developing preliminary the two teachers were requested to collect relevant material covered by the illustrated topics, not the way they were represented. (Narrative 961115)

With a definite purpose, the discussions held in this study were used to show that specific STS issues could be represented and understood using various reasoning approaches. The author attempted to convey an idea that teachers’ pedagogical content knowledge, not only the content knowledge itself, was helpful for students to learn scientific concepts. However, Ms. Mei did not pay attention to the pedagogical level. She still focused on the novel material that could be learned from the discussions.

B. During this phase, the author confirmed the finding that Ms. Mei’s misunderstanding and Mr. Long’s not understanding of the role of technological issues was important in outlining the STS modules.

According to the issues proposed in the meetings, the two teachers were requested to collect relevant information independently for developing preliminary STS modules. In the meantime, the feasibility and the significance between possible topics were compared. Thereafter, Ms. Mei and Mr. Long agreed to adopt the issue of water for developing STS modules in the third phase.

Both of them told me the reasons included:
(1) Water is significant in maintaining human life,
(2) There are rich resources in daily life,
(3) Many topics related to water exist in various courses at the k-12 levels, and
(4) Abundant relevant exhibits and activities are available in the science museums.

Based on the issue of water, Ms. Mei finally narrowed down her topic to “the importance of water resources”, and Mr. Long entitled his “water contamination” for developing preliminary STS modules infused with museum resources in the next phase. (Narrative 961127)

According to the issues they chose, Ms. Mei and Mr. Long were requested first to design guidelines for scaffolding complete forms in the future. Their paper-work was shown to peers during a peer review meeting.

Today, teachers turned in their paperwork during the peer review meeting. We focused the discussion on what they wrote. Their first drafts were presented in a script format. Several corrections were needed in both drafts. The drafts did not contain too much material. They just showed guidelines for further development. In truth, I cared more about how they used the societal and technological issues since what the objective was to design STS modules. However, I found societal issues took precedence over technological issues, and there was no obvious evidence of the use of technological issues. That suggested that the teachers really did not understand the role of technology in science teaching, or even in STS modules. In order to clarify, I asked them: “Could you tell me where technological issues are in the draft?” Ms. Mei pointed out that she designed a series of experiments for students to clarify the nature of water and its application in daily life. These experiments included 1) the test of water content in food, 2) the study of physical and chemical properties of water and 3) the comparison of water and with other liquids.

I followed up: “Do you think these experiments will help students learn a specific concept?” She said: “The experiments show the nature of water to students. In addition, student can learn process skills while doing science.”

I was not sure if she really knew that the adoption of societal issues and technological devices are equally important in STS modules. I asked her the differences between skills used in learning science and technology. She said: “To fulfill the purpose of teaching science, we have to provide students with the opportunities to get hands-on experience. Through working with experiment, students can use technology in laboratory work. That is why I wanted to infuse experimental work into each activity. Besides that, I expect student to learn scientific process skills through experiencing the steps like observation, recording, discussion, and summarization.” Apparently, Ms. Mei mistook the skills to be so-called technology. (Narrative 961212)

Ms. Mei thought that students could learn skills and technology used in scientific work through doing experiments. Unfortunately, proceeding the experiment, she did not introduce any scientific principles that were used in designing technology. Apparently, Ms. Mei mistook process skills as technology in the STS modules. That is why Ms. Mei devised a series of experiments for students to manipulate scientific process skills to satisfy the requirements of the technological part of the STS module.

C. Ms. Mei’s Misconceptions about STES and STS were confirmed from her developing a module labeled as STS.

Ms. Mei revealed her confusions, as discovered in the discussion sessions during the first phase, about STS and STES in the developed module. Obviously, she avoided environmental issues in order to cope with the definition of the STS modules.

I was worried that module which focused on lab work would not
match students’ daily lives. I suggested that she use the environmental issues which occurred in the community to arouse students’ motivation. Responding to my recommendation, she proposed the reason similar to what was shared during the first phase even though some examples of correct STS modules had been given to her as reading and discussion assignments. Ms. Mei’s defense of her module was that: “As I understand the concept, environmental issues must be included in so-called STES modules. The purpose is to explain the related ecological concepts. However for STS modules, the societal issues should be used to help the learner understand the meaning of general scientific concepts.” (Narrative 961212)

In other words, Ms. Mei’s own definitions of STS and STES kept her from freely choosing appropriate issues for developing STS modules.

D. In developing Museum-Based STS modules, Ms. Mei and Mr. Long used teaching strategies similar to what they used for classroom lessons.

Table 2 shows a flowchart of the activities developed by Ms. Mei and Mr. Long.

<table>
<thead>
<tr>
<th>Mr. Long</th>
<th>Ms. Mei</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before setting out</td>
<td>Orientation session for understanding the whole-day schedule</td>
</tr>
<tr>
<td>Field trip</td>
<td>Transportation to location 1</td>
</tr>
<tr>
<td></td>
<td>Study at location 1 along the upstream portion of the Ta-Ka River</td>
</tr>
<tr>
<td></td>
<td>Transportation to location 2</td>
</tr>
<tr>
<td></td>
<td>Study in location 2 along the upstream portion of the Ta-Ka River</td>
</tr>
<tr>
<td></td>
<td>Transportation back to the exhibit hall at NMNS</td>
</tr>
<tr>
<td></td>
<td>Viewing relevant exhibits</td>
</tr>
<tr>
<td>Exhibit hall in the NMNS</td>
<td>Science Lab at NMNS</td>
</tr>
</tbody>
</table>

In the developed module, Mr. Long scheduled a field trip just prior to a session including an indoor activity, which involved viewing exhibits in a science museum. This module needed one full day to finish. Mr. Long explained why he juxtaposed indoor and outdoor learning environments:

There are two major parts to my module. I first conduct a field trip so that students can examine an aquatic habitat along the Ta-Ka River. The children can observe environmental changes caused by human activities. After this, we will return to the science museum to view a diorama representing the wetlands around the mouth of Ta-Ka River. The view shown in the diorama is an ideal environment rich with birds and sand invertebrates. I want the children to compare the ideal and real conditions along the river. (Narrative 961221)

From the following narrative, the method in which Mr. Long arranged the learning activities showed his attitude toward field trips:

Mr. Long selected two spots along the Ta-Ka River, one mid-stream and another near the mouth, so that the children could observe and compare features. Along with the children, he also invited an ecology expert. Before the fieldwork began, the expert explained the purpose of the trip. Then, Mr. Long distributed worksheets to the children and explained the use of water-insects as indicators of water quality. After that, all the children were allowed to enter the wetland area to detect and collect water insects. They repeated the procedure at the second location. Finally, the data recorded on the worksheets were compared and then used for making conclusions. (Narrative 970108)

The use of the outdoor environment dominated Mr. Long’s module. However, the author once claimed the adoption of museum resources should be taken as the first priority in the module-developing process. Obviously, Mr. Long continued to use outdoor activities, which echoed his preference in teaching science.

The use of museum resources was not placed as the central part in his module.

Table 2. Flowchart of Activities in the Development of Mr. Long’s and Ms. Mei’s Modules
Museum-based STS module developed by science teacher

3. Phase III

During phase 3, preliminary modules were submitted for peer reviews. The interviewers suggested ways for refinement. Then, the revised modules were practiced in a classroom setting. According to the observation on their practice sessions, interviews, and cross-examination of the data from the previous phases, the following findings were reported:

A. Judging from their lesson plans during the 2nd phase and practices in this phase, it was found that the teachers used various methods to teach but tried to cover too much material in their STS modules.

Ms. Mei and Mr. Long tried to utilize a variety of teaching strategies in the developed modules. They believed that the adoption of non-traditional ways in teaching science was one of the basic criteria for STS teaching. Although the teachers used a variety of teaching strategies, neither of them successfully played the roles of facilitator or integrator in the classroom. Unlike regular school teaching, they intended to use more methods and materials in their teaching modules. For instance:

The instructional strategies shown in Ms. Mei’s module included:
(1) Observation, data collection, and comparison through the experimental process,
(2) Small-group discussion,
(3) Teacher-led whole-class discussion,
(4) Oral presentations in class,
(5) Teacher-guided tour of the exhibit hall,
(6) Interpretation, and
(7) Student worksheets.

Ms. Mei used the following materials:
(1) Exhibits,
(2) Worksheets,
(3) Handouts,
(4) Resource persons, and
(5) Experimental apparatus.

Although Ms. Mei planned various teaching methods in her module, I found she did not organize these methods effectively according to my observation of her practice session. For instance, she used the one-way transmission of knowledge most of the time. Ms. Mei asked her students to follow certain guidelines for whole-class discussion. When they missed a point, Ms. Mei did not promptly respond as a facilitator to clarify the core issue. Ms. Mei also assigned a representative from each group who would present the ideas shared in the group. During the presentations, most of the students did not hit the point. Facing this situation, Ms. Mei did not make any attempt to help the students elaborate their ideas. She just kept listening without providing any assistance. (Narrative 970312)

Moreover, the STS modules developed by these teachers covered too much material. Ms. Mei and Mr. Long needed 3½ hours and one whole day, respectively, to complete their modules. After the practices, both teachers said:

The time was too short. I could not complete my teaching according to the schedule I set before. (Narrative 970312)

Even after obtaining the comments from peers, both teachers merely made minor revisions.

Although the practice took too long, Ms. Mei and Mr. Long insisted on keeping the structure each had already developed. In truth, according to their paperwork and practice sessions, I suggested they delete some parts that would not change the main idea of the plans. However, Ms. Mei justified the amount she covered by saying: “I believe one of the reasons for students to learn science is to obtain something solid. That is why I included many concepts in my module.” This kind of explanation at least helps me understand why she wanted to keep so much material rather than convey major concepts through the module. (Narrative 970323)

Actually, although she was aware of the time constraint, Ms. Mei only made one minor revision by deleting one unit from her module. Also due to time constraints, Mr. Long distributed guidelines for the field trip as a reading assignment one day before. Therefore, the children were provided with enough time to understand the objective and procedure of the activity.

Interestingly, neither teacher commented the material covered was too much. They simply wanted to keep materials already infused into the module. Instead of learning from their experiences provided in the informal settings, they cared more about the quantity of the material in the modules.

The experience of the field trip to the Ta-Ka River showed the children that learning science was fun. However, because the trip to the study sites consumed a lot of time, only 45 minutes were left for viewing the related museum exhibits after they returned. In his revision, Mr. Long decided to reduce the time used for the field trip. However, he kept the outdoor fieldwork in the module rather than the museum visit. I guess Mr. Long’s plan must be according to his preference for fieldwork rather than the museum-based studies. Mr. Long said: “The time provided for studying the indoor exhibits was not adequate. Actually, the field trip was time-consuming. It was necessary to shorten the time at each site. Because of the time constraints, I also found that the summary discussion was not good, either.” I wonder why Mr. Long never thought about whether the outdoor fieldtrip was necessary for developing the museum-based STS module or not. He still insisted on including outdoor activities in the module. (Narrative 970323)

As mentioned above, Ms. Mei was inclined to hold an empiricist’s view of the science. It is, therefore, not surprising that she included a series of experiments in her module.

Ms. Mei explained her purpose for including a series of experiments: “The experiments provided students with practice of basic scientific process skills.” However, I don’t think it was efficient. Since it took a long time, she had to squeeze study of the related exhibits into a short period of time (i.e., 35 minutes). Although her module was infused
with an abundance of museum resources, I found Ms. Mei had to interpret the exhibits quickly and superficially. (Narrative 970323)

In conclusion, Ms. Mei and Mr. Long used various teaching strategies and covered museum resources in their practice, but did not adopt museum resources as the central part. Therefore, the modules they developed did not really meet the criterion of so-called museum-based STS modules.

B. Mr. Long agreed that this project was helpful in improving his teaching through understanding the rationale of STS module. On the contrary, Ms. Mei did not think the STS modules in general were applicable in a secondary science class, not to mention the museum-based STS modules.

After the practice in the classroom setting, the author asked the teachers what they obtained from the development process of STS modules. Mr. Long mentioned his teaching benefited from the understanding of the theoretical basis of STS by participating in the project.

While I asked him how he felt about the development work, Mr. Long noted: “I learned a lot through the development process. After comparing the experiences obtained during this project with the way I used to teach, I learned how my usual teaching techniques could be refined by adopting the theoretical basis into practice.” Since I requested him to explain more accurately, he added: “After attending the development process, I became more familiar with teaching strategies used in STS education. I become to understand what science educators mean by STS and the way to develop STS modules. Through this process, I have also had a chance to reflect on what and how I teach my elementary school science courses. The views of my colleagues helped me refine my teaching skills. I guess these will be applicable to my classes.” (Narrative 970406)

On the contrary, Ms. Mei did not think museum-based STS modules were feasible at the secondary school level.

Ms. Mei, as a secondary teacher, was concerned more about the feasibility of using STS strategies in her regular science classroom. She mentioned: “the busy schedule and the individual differences among junior high students were barriers to using STS at the secondary school level.” She emphasized that a discrepancy exists between theory and practice. She said: “I do not think it is feasible in my science classroom. There is no doubt that “A” students will learn something no matter what teaching methods are used. On the other hand, even if STS strategies were used in teaching, “C” students would still have no motivation to learn.” She even used pessimistic words such as “Museum-based STS modules had little possibility of being used in real science classrooms.” to expressed her opinion about the adoption of STS teaching at the secondary level. (Narrative 970406)

Ms. Mei indicated the busy schedule and the individual differences were the major barriers to the implementation of STS for junior high students. Influenced by her pessimistic view, Ms. Mei questioned the effectiveness of attending this project. Therefore, she treated the development work as being a task-oriented process rather than an opportunity for empowerment. Ms. Mei was not willing to adjust her teaching techniques to be faithful to the spirit of STS. She complained that informal setting was quite different from that in school.

Ms. Mei complained: “It was not necessary to use the resources in the science museum to develop the STS modules for the topic we had chosen.” Even though the purpose of the work was communicated frequently throughout the study, Ms. Mei still stood on the side of formal education. She was reluctant to use the resources in an informal setting and continued complaining about the requirements to infuse the resources. I can understand her suspicion on the application of museum resources in the real teaching. (Narrative 970415)

Actually, Ms. Mei always questioned the effectiveness of the museum-based modules, although she understood the purpose for this study. Regrettfully, this development process did not convince Ms. Mei of the importance of informal settings for her teaching.

IV. Discussion, Conclusions, and Recommendations

In this section, two aspects of the problems are summarized according to the findings of this study. Here, the author also attempts to provide the possible strategies for overcoming these problems.

Problem 1: The teachers did not really understand the role of technology used in the STS modules, which might result in teachers’ incompetence in developing appropriate STS modules.

Strategy 1: Science teachers should be trained to adopt suitable technological issues to present reasonable connections between science and technology in their lessons.

In this study the author presented two teachers who did not really understand the role of technology and its meaning in the STS module. Truly speaking, the power of technology in teaching science is indisputable, and it is recommended that science teachers be trained with the competency in adopting suitable technological issues and presenting the reasonable connection between science and technology in their lessons (Holford, 1983). Two explanations might provide the answers:

(1) The curriculum design in the pre-service science teacher programs is not relevant to technology. Taiwanese science teachers are therefore not prepared with the beliefs and skills needed to incorporate tech-
nology into real teaching.

(2) The objective of science education in Taiwan is dominated by the transmission of material knowledge in a specific area of science. In general, the teachers in Taiwan do not have a wide range of background in integrating the teaching materials. Therefore, it is understandable that science teachers are not trained with enough information in technology.

The use of technological issues in teaching science has received little attention from traditional science educators in Taiwan. However, in order to keep the pace with society, building the connections between learning activities and learners’ experience is urgently needed. Teachers need to learn the ability to incorporate interesting issues to teach STS-oriented science in both formal and informal settings. Teachers first need to understand the rationale for STS and how science impacts human life via technology. Undoubtedly, teacher programs, both in in-service and pre-service, should provide such opportunities for empowerment. Teacher education program should be enriched with STS elements. Indeed, the curriculum for future teachers ought to educate them on how science interacts with society by means of technology. Furthermore, the scope of teacher education should not be confined solely to subject matter knowledge and the strategies for presenting such knowledge. Prospective science teachers need a learning environment that will broaden their general background. The author strongly suggests that teacher educators create an atmosphere in which pre-service science teachers can experience the interaction between the scientific and humanistic worlds.

Zoller, Donn, Wild, and Beckett’s study (1991) reported the fact that teachers did not have adequate STS-literacy. The author agrees with their suggestion that teachers need to understand (1) the nature of science and technology, (2) the differences between them and (3) their interrelationships. Undoubtedly, the nature of science should be emphasized during the teacher education program. Also, the author would like to add the need for the study of the history of science in teacher preparation. If some historical cases of science are presented in an appropriate way, it might help teachers understand not only the development of science but also its interactions with various aspects of the real world.

Problem 2: Because teachers were used to developing school-based learning activities, they had difficulties developing STS modules when requested to adopt museum resources.

Museum-based STS module developed by science teacher

Strategy 2: Assistance should be provided to improve STS literacy for teachers, and increase their knowledge in museum education through both pre- and in-service programs.

The science classroom in Taiwan has traditionally been textbook-dominated, teacher-centered, and concept-focused. Educational resources outside the formal educational system have not received enough attentions. The findings of this study tell us that neither teacher was able to develop logical and applicable STS modules based on the museum resources and context.

As mentioned previously, the teachers in this study showed that they had trouble defining STS education correctly, using the effective strategies in STS teaching, and adopting suitable technological and societal issues. Moreover, they also showed their lack of knowledge concerning about informal contexts. Although they tried to justify what they did in the developed modules, unfortunately, their existing perceptions of teaching in the science museum were apparently major barriers to changing their techniques. The museum setting seemed to be an alien world for them. The following list of findings from these teachers can more or less describe the limitations of their thinking and actions in teaching science:

(1) They still emphasized the children should learn certain solid materials. Thus, too much material was attempted to be covered in their STS modules. What they taught focused more on content than on strategies.

(2) They were not confident that the student-centered strategy would be more effective than teacher-dominated instruction.

(3) Although they used various methods in teaching the scientific concepts, the strategies were not organized systematically or logically.

(4) They did not master the use of museum materials in place of the classroom setting when needed.

(5) They were in a dilemma as to whether to use the methods they preferred or adjusting themselves to meet with the requirement of museum-based STS modules.

Although previous studies in Taiwan have reported the advantages of STS strategies for the reform of teaching science in a classroom setting, this study showed that museum-based STS modules were developed with more difficulty than the modules directly used in the school learning environment. This finding tells us assistance to teachers is needed if they want to extend their teaching of science outside the classroom setting. For those in-service teachers who will face the adjustment of science curriculum in the near future,
their ability in developing the teaching activities should be promptly improved (Pedretti & Hodson, 1995). The author argues that the assistance ought to be provided through two approaches: the first, as I mentioned in the previous section, is the improvement of STS literacy of teachers, and the second is the increase of knowledge in museum education. According to the evidence obtained from this study, I suggest the first approach should be placed ahead of the second one. Since after the STS literacy is established, it could scaffold the teachers’ extensive abilities in using the museum resources and context to teach science. Nevertheless, one of factors that determines whether teachers will make change or not is their belief in education. Hunsacker and Johnston (1992) claimed the changes of teachers’ beliefs could only occur through long-term professional development. Therefore, teacher empowerment programs such as workshops, seminars, discussion groups, and demonstrations should be provided to help teachers conduct long-term meta-cognitive reflection.

In order to reshape Taiwanese teachers’ views of education, the author recommends teacher educators involve museum curators in education. As one of the most vital elements of non-formal education, museums should not be absent from teacher education. Curators’ efforts to work with the formal educational system are also needed. Museums need to develop the suitable programs for enriching teachers’ museum experiences, which can serve as a foundation for the use of museum resources in their teaching.

In conclusion, an informal learning setting is much like a promised land waiting for Taiwanese teachers to explore. Although teachers’ knowledge of and strategies for using resources in informal settings are generally not adequate, growing calls for change will force Taiwanese teachers to take action to enhancing their teaching. Based on the rise in the number of informal educational institutes in Taiwan during the past decade, it is believed that schoolteachers and parents will become more acquainted with the roles of informal settings if the resources are easy to access. Therefore, in order to help our future generations learn through the multiple channels, science museums should devote more energy to making connection with formal education. Once again, the stories about Mr. Long and Ms. Mei developing museum-based STS modules reminds us that curators should be actively involved in teacher education. Actually, teachers need assistance, not just top-down orders, when they are requested, or even taking the initiative, to enrich their instruction by using social resources such as in a museum setting. Teacher educators and museum curators should not leave teachers alone while they pursue new techniques in teaching!

Acknowledgment

The author wishes to thank the National Science Council for funding this research (NSC 86-2511-S-178-001).

References

ASTC Newsletter. (1994). Informal science education efforts on rise, but their impact remains unclear, study suggests, ASTC Newsletter, 22(3), 1.3.
Huang, C. C. (1992). The study of the strategies to make the collabora-

C. C. Chin
Museum-based STS module developed by science teacher

tive relationship of schools and NMNS (In Chinese). Taichung, Taiwan: NMNS.

兩位科學教師發展以科學博物館情境資源為核心之STS教學模組的啓示

靳知勤
東海大學教育研究所暨教育學程中心

摘 要

本研究以國小自然與國中生物科教師各一為個案，探究其以科學博物館情境與資源為核心，從事STS教學模組開發過程中之信念與實際表現。歷程中採質性研究法蒐集資訊，並撰寫敘事方式記錄及分析研究資訊。研習結果顯示：個案教師從事本類STS教學模組之開發，深受其對STS理念之認知、對教學之認識，以及台灣社會對科學教學目標之界定所影響。個案教師在發展教學模組之過程中，因受從事教育之原有信念及對利用科博館資源之刻板認識，而少有改變。尤其是在符應以科博館資源為基礎之要求方面，其遭遇之難度，顯然較以學校本位之模組開發為高。其從事非制式教育情境之安排與應用，對於個案教師而言，猶如開啓另一未曾熟悉之「新大陸」一般。作者建議以教育日益強調多元呈現的趨勢而論，及時彌補教師對於制式教育與非制式教育間認識之鴻溝實屬必要。而於職前與在職師資教育階段，加強此方面的認識應是可行之途徑。

— 125 —