



## Evaluation of Informal Science Teaching Experience at Science Museum for Preservice Science Teachers

Wahyu Setioko<sup>1</sup>, Karen E. Irving<sup>2</sup>

### Abstract

*This study investigated how an informal science teaching experience at a science museum changes preservice science teachers' communication skills in teaching science. Such skills are important to support teachers' pedagogy, classroom management and positive learning environments in science classrooms. Video recordings, field observations, individual interviews, and focus group discussions were conducted to document changes of the teachers' performances when presenting science to visitors as well as to investigate elements of the experience that contributed to these changes and teachers' learning. Communication skills' analysis focused on verbal language dimensions and teaching style dimensions. Findings showed that a majority of the teachers showed improvements in their communication skills. The experience influenced the teachers to provide contextual examples in explaining science, to communicate more effectively using fewer filler words, to adjust the amount of technical words based on visitors' characteristics, to engage visitors with more constructive open-ended questions and more elaborative feedback, and to use more Initiation-Response-Follow up (IRF) patterns at the end of the experience. The dynamic nature of their interactions with museum visitors, the informal learning environment, and support from museum educators contributed the most to the teachers' growth. They also reported gains in science content knowledge and self-efficacy. Results of this study are useful to design effective collaborations between university and science museums for advancing science teacher education.*

### 1. Introduction

Teachers' communication skills play important roles in science teaching, from supporting teachers' pedagogy in delivering science concepts effectively to students, to helping teachers in managing classrooms and creating a positive learning environment in science classes [1,2,3]. Such skills are gained from an authentic science teaching experience outside of traditional coursework. As learning to teach occurs across contexts [4], researchers suggest the potential of incorporating science teaching experiences into science teacher education programs that go beyond classroom settings [5]. Informal science education settings provide a rich context and an authentic and powerful science teaching and learning experience for preservice teachers [5,6,7]. A science museum is one of those potential informal science education settings for preservice science teachers practicing their science teaching through communicating science topics and concepts to diverse people, in terms of ages and education level. This study investigated how an informal science teaching experience at a science museum influenced preservice science teachers' communication skills and what elements of the experience contributed to the teachers' learning.

### 2. Methods

Four preservice science teachers at the The Ohio State University participated in a 7-days (over seven weeks) informal science teaching experience at the Center of Science & Industry (COSI), Ohio, as a part of their graduate Science Education program. Orientation about informal science learning was conducted by museum educators on the first day. On five additional days, the teachers taught and communicated certain science concepts (e.g. electromagnetism, human and animal skulls, or fossils and artifacts) to visitors using hands-on materials on a cart on the museum floors. Finally, a wrap-up session with a focus group discussion was held to reflect teachers' learning throughout the experience. Two video recordings (at the beginning and the end of the teachers' teaching performances) were conducted to analyze changes in communication skills when teaching science concepts to visitors. Measurement of communication skills focused on verbal language dimensions (e.g. use of academic language, example quality, and vocal filler repetition) and teaching style

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<sup>1</sup> The Ohio State University, Indonesia

<sup>2</sup> The Ohio State University, United States of America



dimensions (e.g. questioning, feedback, and communication pattern). Coding schemes were assigned for evaluating teachers' skills in giving supporting examples, asking constructive questions and giving feedback during their teaching (Table1). For other communication skills dimensions, we counted the percentages of technical words and vocal filler words used by the teachers in their informal teaching. Lastly, we observed teachers' communication patterns, whether they used an Initiation-Response-Evaluation (IRE) pattern or an Initiation-Response-Follow up (IRF) pattern [8], when teaching science to visitors. Furthermore, qualitative data were obtained through field observations, individual interviews with the teachers, and focus group discussion to examine teachers' learning throughout the experience as well as elements of the experience that contributed to their learning.

Table 1. Coding scheme for teachers' communication skills dimensions.

| Category        | Value  |  |   |  |
|-----------------|--|--|---|--|
|                 | 0  | 1  | 2   | 3  |
| Example Quality | Explaining scientific concepts without daily life examples | Poor examples (examples given are not related and not contextual)      | Good examples (examples given are related with the topic, but not contextual) | Excellent examples (examples given are related with the topic and contextual)            |
| Questioning     | No or unrelated questions used in the teaching             | Close-ended or choice (yes/no) questions                               | Open-ended questions initiated by the teacher                                 | Open-ended questions built on students' or visitors' responses                           |
| Feedback        | No feedback given during the teaching                      | Evaluative feedbacks (judgement, praise, evaluation, general comments) | Corrective feedbacks (correction, verification, direct hint, try again)       | Elaborative feedbacks (addressing information, identifying misconceptions, asking 'why') |

### 3. Results and Discussion

#### 3.1 Changes of Preservice Science Teachers' Communication Skills

At the end of the informal science teaching experience at COSI, a majority of the preservice science teachers showed improvements in verbal language dimensions and teaching style dimensions of their communication skills. Figure 1 shows the absolute changes of the teachers' communication skills with respect to example quality, questioning, and feedback categories, while Figure 2 shows the absolute changes in the teachers' communication skills with respect to vocal filler words, technical words, and communication pattern categories. However, in the discussion below, we reported the changes in relative difference, instead of absolute differences.

Figure 1. Changes of preservice science teachers' communication skills at the end of informal science teaching experience at science museum (for example quality, questioning, and feedback categories).

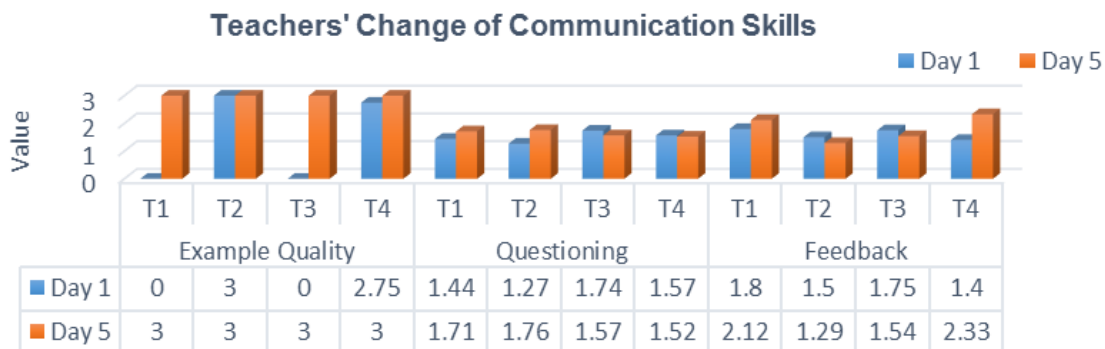
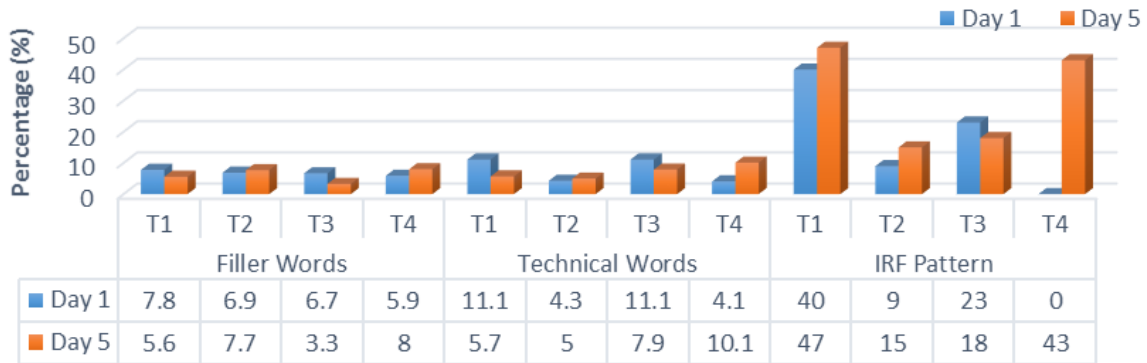




Figure 2. Changes of preservice science teachers' communication skills at the end of informal science teaching experience at science museum (for vocal filler words, technical words, and communication pattern categories).

**Teachers' Change of Communication Skills (cont.)**



**3.2 Changes in Verbal Language Dimensions**

In this study, verbal language dimensions are divided into three sub-categories, i.e. example quality, vocal filler repetition, and academic language. Example quality category evaluates the explanatory examples given by teachers to help visitors understand science concepts. Teacher1 (T1) showed an improvement in this category by using excellent examples to support her explanation at her final teaching performance. Teacher2 (T2) already possessed skills to provide excellent examples in her teaching both at the initial and the final observations. Although there are some changes showed in Fig. 1 for Teacher3 (T3) and Teacher4 (T4) in this category, improvement for T3 and T4 could not be clearly determined because both of them taught different science topics on the initial (Day1) and the final (Day5) teaching performances. The teachers tend to give excellent examples for skulls and fossils topics (three excellent examples in average) compared to electromagnets topic (0-1 examples). Vocal filler words category evaluates the effectiveness of teachers' communication by counting repetitive vocal filler words. Examples of vocal filler words include, "like", "right", "cool", "so", "okay", "I mean", "you know", "basically." Although we expected that the teachers would decrease their use of vocal filler words in science explanation by the end of the experience, only half of the teachers actually achieved that goal. Teacher1 and Teacher3 reduced their filler words at the final performance by 28% and 50.8% respectively, compared to their initial performance. In contrast, Teacher2 and Teacher4 increased their vocal filler used by 11.6% and 35.6% respectively.

Academic language category evaluates the type of words used by teachers in their explanation of science concepts. Result shows that Teacher1 and Teacher3 were able to adjust their language in informal setting by reducing technical words by 48.7% and 28.8% respectively at the end of the experience. In contrast, Teacher4 significantly increased her technical words at the final performance by 146%. Teacher2 was able to adjust her language by using eight different technical words to elementary school-age visitors while she used 15 different technical words to older visitors (middle or high school level). Both the age of the visitors and the science cart content topics affected the preservice teacher's use of academic terms in their explanatory segments.

**3.2 Changes in Teaching Style Dimensions**

Teaching style dimensions in this study are divided into three sub-categories, i.e. questioning, feedback, and communication pattern. The questioning category evaluates the quality of questions used by teachers in their teaching and communication with visitors. Teacher1 & Teacher2 showed improvements in their skills of using more engaging questions (value 2 and 3 in Table 1) in their final teaching performance. Teacher4 used both of the constructive open-ended questions (value 2 and 3 in Table 1) more often at the end of the experience although overall changes showed a slight 3.5% diminishment. Teaching style analysis for Teacher3 & Teacher4 were complicated by the nature of visitors they had on Day1 (adults) and on Day5 (children). Regardless of the changes, all of the teachers tended to use more close-ended questions to younger children (elementary or below).

Feedback category evaluates the type of responses used by teachers in their teaching and communication with visitors. Although we hoped the teachers would use more constructive feedback by the end of the experience, only half of the teachers actually demonstrated that. Teacher1 and





Teacher4 gained 17.7% and 66.7% improvements respectively by using more elaborative feedbacks at the final performance, compared to their initial teaching. On the other hand, Teacher2 and Teacher3 used evaluative feedbacks more often at the end of the experience.

The communication pattern category evaluates the frequency of IRF patterns (constructive dialogue pattern) used by teachers in their teaching and communication with visitors. Teacher1 and Teacher2 gained 15% and 40% improvements respectively in this skill. Teacher4 showed a significant change from Day1 where he used no IRF pattern at all to adult visitors, to Day5 where he used 43% of IRF pattern when teaching children. Teacher1 and Teacher4 showed a more balanced IRE-IRF pattern on the last day. Generally, all of the teachers tended to use IRE patterns more dominantly than the IRF.

### **3.3 Contributions of Science Museum Experience for Preservice Teachers' Learning**

Teachers reported that the following factors contributed to their improvements:

- Informal learning environment, allowed them to practice teaching and apply knowledge from coursework and to experiment with different teaching pathways in a low-pressure environment.
- Mentoring with museum educators during or after the teaching.
- Teaching science carts repetitiously to various kinds of visitors, allowing them to adjust content, instruction, language, and teaching style to different visitors. Teachers learned to assess visitors' prior knowledge and interest towards the science topic to adjust their teaching.
- Orientation and training at the first day about how people learn science in informal setting.

In addition, participants also reported gains in science content knowledge and self-efficacy.

## **4. Acknowledgement**

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