Augmentation of Interactive Science Communication using Sign Language

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Abstract: Learning outside of a school environment is important for us because much of our time is spent outside of school. Museums, in particular, are important for lifelong learning. To improve accessibility of information for science communication in museums based on the principles of "universal design" and "design for all," we consider universal access for d/Deaf and hard-of-hearing visitors. This paper introduces the necessity of improving information accessibility for d/Deaf and hard-of-hearing visitors, followed by specific methods for them to learn freely and spontaneously in aquariums. Curators who were able to use sign language to provide scientific communications were trained, and then accessibility methods acceptable to d/Deaf and hard-of-hearing visitors to augment interactive science communication in aquariums were surveyed through a demonstration experiment. Four information guarantees were provided: distribution of explanations, explanations by sign language interpreters, sign language explanations with signboards, and face-to-face lectures in sign language. The merits and demerits of each type of information accessibility were assessed via a questionnaire.

1 INTRODUCTION

Since the establishment of the Disability Discrimination Act (ADA) in 1995, advocacy for persons with disabilities has been a priority for most institutions. Museums have therefore continued to proceed with concepts of the "inclusive museum" (GMA, 2017) and universal access (Smithsonian 2011).

However, Atkinson (2012) has warned that, while exploring a museum collection constitutes a very visual experience, "deaf audiences are one of the most neglected by museums." Martins (2016) reported that deaf visitors' engagement is enhanced when tours are given by deaf tour guides. Goss (2015) advised that a wide range of multilingual communication needs is required for a diverse range of museum visitors who are d/Deaf or hard-of-hearing.

Unfortunately, there are few museums taking such actions in Japan. Most content for people with hearing disabilities is insufficient from the viewpoint of universal design and accessible design. Therefore, we aim to explore the different communication resources required by d/Deaf or hard-of-hearing visitors to break down the barriers they face in science museums. d/Deaf or hard-of-hearing visitors to museums can be categorized into three groups: 1) Spoken-Focused, 2) Simultaneous Language, and 3) Sign Language-Focused (Goss, 2015). In this study, we focused on sign language users.

2 RELATED RESEARCH

In this section, we explain our previous studies to improve information accessibility for visitors to aquariums who are d/Deaf or hard-of-hearing.

We conducted a survey of people with hearing impairment concerning museums, including art museums, science museums, historical museums, culture halls, botanical gardens, zoos, and aquariums.

We obtained responses from 70 people with hearing disabilities. We asked them 27 questions, from June 30th, 2017 to February 21st, 2018.

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The following graph (Figure 1) shows the result for the question: “Have you ever been to a museum?” Among d/Deaf or hard-of-hearing people, 93% had visited the aquarium, 89% the zoo, and 77% the science museum. No person was found who did not have the experience of using at least one of these museums.

These results show that museums were popular among people with hearing loss. However, their opinions were as follows.

1. Most explanations are verbal, so I am in trouble.
2. I do not visit because I cannot obtain information and enjoy it.
3. I want to know more! I want to learn more!
4. Because there is no sign language interpreter, I don’t know what I want to know.

Opinions 1–3 show the need to devise information accessibility for d/Deaf and hard-of-hearing visitors to learn independently and spontaneously at aquariums and with freedom and enjoyment at museums (Falk, 2001). Therefore, we initially provided Japanese sign language explanations via Quick Response (QR) code technologies at an aquarium in Japan. The demonstration experiment for d/Deaf or hard-of-hearing people was conducted at the aquarium on November 27th, 2018. The opinions of eight participants were gathered via a questionnaire. An opinion was also expressed that explanations in sign language are more impressive than written explanations. People highly appreciated being able to watch the sign language commentary while observing the fish. We investigated the effect of sign language content with experimental proof (Namatame, 2019), including Japanese sign language content published on an official aquarium website in September 2019 (Figure 2). This content has grown to 1,500 pageviews per month.

However, this method could not solve the aforementioned opinion no. 4, so d/Deaf curators were nurtured in our educational program to remove the science communication barriers that accompanied interactive conversations. The training program was conducted from September 7th, 2019, to December 5th, 2019. The curators required conversational skills to provide visitors with new knowledge and excite their curiosity as well as the ability to answer questions correctly (Figure 3).

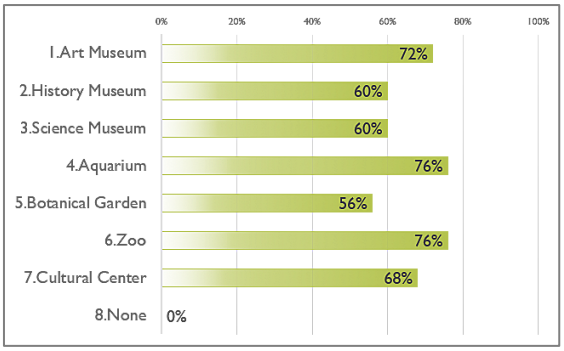

Figure 1: Current status of museum usage (hearing loss).

Figure 2: Screenshot of sign language content.

Figure 3: Snapshot of the face-to-face lecture.

3 RESEARCH QUESTIONS AND METHODS

To remove barriers to scientific communication associated with interactive conversations in the aquarium, we extracted concrete scenes and attempted solutions based on a demonstration experiment, in which people who were d/Deaf or hard-of-hearing participated.

Our research questions were as follows.

1. What is the most accepted method of augmenting interactive science communication in an aquarium for d/Deaf or hard-of-hearing visitors?
2. What are the acceptable and/or unacceptable features of such methods?

4 RESEARCH DESIGN

Specifically, the following, which guaranteed information accessibility for the disabled, was prepared to obtain evaluations through a demonstration experiment and attempt to identify problems.

1. Distribute the explanation documents for the curator's audio commentary.
2. Support the curator's sign language commentary with a signboard displaying Japanese written text.
3. Have a sign language interpreter collaborate with the curator's audio commentary.
4. Provide explanations in sign language by a curator with a hearing impairment through face-to-face communication.

The demonstration experiment participants enjoyed the exhibition together with the general public. Once the aforementioned experiment was completed, the participants evaluated it via a questionnaire.

The evaluations used a six-step Likert scale (1: strongly disagree, 2: disagree, 3: somewhat disagree, 4: somewhat agree, 5: agree, 6: strongly agree) and were separated into two for totalization (agree or disagree). Participants were required to provide the reasons for their evaluations.

5 RESEARCH IMPLEMENTATION

The demonstration experiment at the aquarium was conducted on November 29th, 2019. Five university students who were d/Deaf or hard-of-hearing participated. Their sign language career experience was about 20 years (the career of one person was four years), and they were regular sign language users. All the participants liked the aquarium. They followed the exhibits along the aquarium route. Information accessibility for d/Deaf or hard-of-hearing participants with voice commentary had been prepared at the following popular points.

1. Sunfish lunchtime (distribute explanation documents of the curator's audio commentary.)
2. Sand tiger shark profile (support curator's sign language commentary with a signboard displaying Japanese written text.)
3. How to distinguish between male and female sharks (have a sign language interpreter collaborate with the curator's audio commentary.)
4. Lecture on shark eggs and skin (sign language explanation by a curator with a hearing impairment through face-to-face communication.)
5. Aqua watching in front of the main tank (free time without information accessibility support).

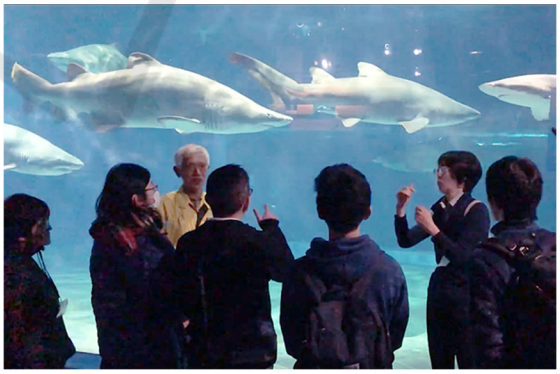

Figure 4: Snapshot of the scene supported by a sign language interpreter.

6 RESULTS

In this experiment, the most interesting content was the lecture on shark eggs and skin, which was selected by three participants, followed by the shark sexing

method, which was selected by two participants. The main reasons included the utility of sign language such as "I could ask questions without hesitation" and "It was an enjoyable and understandable way to obtain information." Another perspective considered learnability, i.e., "I acquired new knowledge" and "I obtained explanation details."

Participants who visited Exhibitions 1 and 5 were dissatisfied because they found them difficult to understand. Exhibition 1: Real-time comments were required, not description documents. Exhibition 5: It seemed like just feeding and was not interesting because only voice information was provided and I could not gain the information such as sunfish life. There was a problem in Exhibition 2 with the visibility of the signboard, and there was an unavoidable time lag in the interpretation in Exhibition 3.

Nevertheless, thanks to effective sign language and sign classifiers, the exhibitions were very imageable for participants. The lively discussion using the haptic materials made the interactive communication easy to understand.

The evaluations of the content are presented in Tables 1 to 5. Enjoyment of "Shark eggs and skin" was evaluated with a high score (Table 1), while the satisfaction, understandability, and learnability of contents supported by sign language were also evaluated highly (Tables 2, 3, 4). "Aqua watching" had no support, and few participants wished to revisit it.

Table 1: Evaluation of enjoyment (number of participants/ disagree 1–3, agree 4–6).

CONTENT	1	2	3	4	5	6
Sunfish	0	0	1	3	0	1
Sand tiger shark	0	0	0	2	2	1
Shark sexing	0	0	0	1	3	1
Shark eggs and skin	0	0	0	1	0	4
Aqua watching	1	0	0	1	1	2

Table 2: Evaluation of satisfaction (number of participants/ disagree 1–3, agree 4–6).

CONTENT	1	2	3	4	5	6
Sunfish	0	0	1	2	1	1
Sand tiger shark	0	0	0	1	2	2
Shark sexing	0	0	0	0	2	3
Shark eggs and skin	0	0	0	1	1	3
Aqua watching	1	0	1	0	1	2

Table 3: Evaluation of understandability (number of participants/disagree 1–3, agree 4–6).

CONTENT	1	2	3	4	5	6
Sunfish	0	1	2	1	1	0
Sand tiger shark	0	0	0	2	1	2
Shark sexing	0	0	0	1	1	3
Shark eggs and skin	0	0	0	1	2	2
Aqua watching	1	0	1	3	0	0

Table 4: Evaluation of learnability (number of participants/ disagree 1–3, agree 4–6).

CONTENT	1	2	3	4	5	6
Sunfish	0	0	0	1	3	1
Sand tiger shark	0	0	0	0	2	3
Shark sexing	0	0	0	0	3	2
Shark eggs and skin	0	0	1	0	1	3
Aqua watching	2	0	1	0	1	1

Table 5: Evaluation of intention to revisit (number of participants/ disagree 1–3, agree 4–6).

CONTENT	1	2	3	4	5	6
Sunfish	0	0	1	3	1	0
Sand tiger shark	0	0	0	0	3	2
Shark sexing	0	0	0	0	3	2
Shark eggs and skin	0	0	0	1	2	2
Aqua watching	1	0	0	1	3	0

7 DISCUSSION

The most acceptable method of guaranteeing information accessibility for d/Deaf or hard-of-hearing visitors at an aquarium was not identified by this demonstration experiment. However, acceptable features for d/Deaf and hard-of-hearing visitors were clearly observed. Providing specific explanations led to audience satisfaction. Furthermore, if a curator explained an exhibition in sign language directly, the audience understood easily and asked questions without hesitation. It is certain that sign language is needed to augment science communications. In addition, the darkness of the lighting environment, a unique problem of museums, was revealed.

Sign language and sign language classifiers have the power to turn abstract concepts, including jargon, into rich, visual expressions. Simultaneous sign language and audio commentary is able to provide scientific communication for both hearing and deaf people. We think this is one way to make science communication easy for everyone to understand.

8 CONCLUSIONS

To achieve this goal, we will be improving information accessibility for the d/Deaf and hard-of-hearing at the aquarium based on the principles of universal design and human-centered design. Our goal is to promote museums to the public for purposes of education, study, and enjoyment without disabilities. In the future, we intend to develop a system to convey the meaning of and interest in sign language to all audiences.

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