

Sydney Science Trail 2022 Evaluation

Event: Sydney Science Trail

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Event description

The Sydney Science Trail is an annual program by the Australian Museum, Royal Botanic Garden Sydney and other partners. It is an opportunity for kids of all ages and schools to think, talk and experience the science conducted at the partner organisations.

A highlight of the Sydney Science Trail is the week-long Science Expo that features the latest scientific discoveries and experiments provided by more than 20 exhibitors showcasing demonstrations and hands-on science fair stalls. FLEET developed an interactive exhibit that was part of this Expo.

FLEET selected four days to attend the Expo: Three days during the week that were attended by secondary and primary schools, and the Saturday when the expo was open to the public.

FLEET objectives for the event

FLEET developed the event to achieve the following outcomes:

- An appreciation/awareness of the purpose and value of FLEET research and physics generally.
- Increased public awareness of the increasing demand for and energy consumption of computation, and the implications of this.
- A public thinking critically about the meaning and value of FLEET research.
- Primary and secondary students with a greater interest in and awareness and appreciation of physics
- FLEET researchers with improved communication skills and greater understanding of audience values and perceptions of physics/FLEET research

Audience and number of engagements

Secondary school students = 300 (approx.)

Primary students = 740 (approx.)

Members of the public = 900 (approx.)

Students entered in groups at allocated times and had one hour to tour the expo and the 20 organizations exhibiting at the expo. Most engagements were less than 5 minutes and nearly all the evaluation occurred on FLEET's first day of attendance. The audience for this day was exclusively secondary students. This limits the understanding of the event's impact.

Key findings

- Exposure of FLEET research to nearly 2000 students and members of the public.
- FLEET volunteers perceived a greater purpose and value to their work, and improved their communication skills.

Method

FLEET used the levitating superconductor as its focal point to attract visitors to the exhibit and to facilitate an engagement about FLEET research. Limited space prevented the use of any other interactivities.

To evaluate the Sydney Science Trail the following pre- and post-evaluation tools were developed:

- Mind map
- Online exit survey
- Survey of FLEET volunteers

Details of each evaluation tool is described below

Mind map

The public were asked to contribute to a mind map that contained the statement, digital technologies use lots of energy. Unfortunately, participation in the mind map requires FLEET members to be proactive and ask people to contribute. As outreach coordinator, I attended the bump-in and first day of the Expo and ensured there was some contribution to the survey and mind map. The exhibit booth also had limited space that made it difficult to place the mind map in a prominent and easily accessible place.

The data on the mind map from the first day and was insufficient to draw conclusion from and is therefore not used to evaluate the impact of this outreach event.

Exit survey

An online survey was also conducted that asked the following six questions:

1. Participant's age
2. Write one interesting thing you remember from your experience with FLEET?

The demand for computation is increasing 70% each year. Digital technologies use about 10% of global energy and this figure is doubling every decade. In the context of this problem, indicate your level of agreement/disagreement with the following statements:

3. My experience today has changed my understanding about society's use of digital technology.
4. Low-energy technologies are unlikely to make a difference to the lives of ordinary people.
5. I am unconcerned because there is always a technological solution to problems such as the energy consumption of digital technologies.
6. I have a deeper appreciation of research and its value.

Participants for the survey were selected at random in that every person I engaged with I encouraged to complete the survey. Participants could access the survey via a QR code. Participants could complete the survey while at the exhibit or later in their own time.

Participation in the exist survey also requires FLEET members to be proactive in getting people to do the survey. People will rarely complete the survey otherwise. As noted, evaluation only really occurred on the first day and therefore only by secondary students.

The reason for this is that I was only available to be at the event for the first day. FLEET volunteers on the other days generally did not encourage people to complete the survey or mind map. Some potential reasons for this are explained below in Reflections.

FLEET survey

Following the Sydney Science Trail Expo, I asked FLEET volunteers to complete an emailed survey to help understand the value for them of such outreach experiences. They were sent the following questions:

The big picture

1. In the context of the value you got from volunteering at Sydney science trail, can you tell me about your experience?

More specific stuff

2. How did volunteering at Syd Sci Trail contribute to your skill set as a scientist?

3. What did you learn about the public's perspective on FLEET's or your own research?

4. How, if at all, did this awareness of the public's perception of FLEET/your research make you think about the role of communication/engagement and how you communicate to others outside your area of research expertise?

General

5. Any other comments you have about the event generally - its value for FLEET, ability to engage with the public, not enough/too many volunteers, more interactive stuff needed...etc

The results presented in the following section are an analysis of the exit survey data and the FLEET volunteer survey.

Results

This section first presents the data from the exit survey followed by the data from the FLEET volunteer survey.

Exit survey.

The total number of survey respondents was 34 and 32 of these respondents are from day 1 of the Expo where all respondents are secondary students. Each survey question is analysed separately below.

Question 1. Participants age

The average age of the exit survey participants is 14.4 years with the oldest student being 16 years (N=1) and the youngest being 11 (N=1).

Question 2. Write one interesting thing that you learned from your experience with FLEET today?

The responses to this question were thematically analysed and the following four themes emerged:

- Levitating superconductor
- Energy use concerns
- Just physics
- Random and abstract

Each of the above themes is analysed in more detail below.

Levitating superconductor: Students (N=24) recalled diverse facts relevant to the levitating superconductor. There was considerable variability in the depth and scientific accuracy of these recollections. Comments included the following:

"You can make a metal float on a magnet if super duper cold."

"Things can float."

"190 degrees"

"A rail road in Japan floated using this technique."

"That liquid nitrogen was air"

Energy use concerns: Student comments under this theme (N=5) reflected their concern about the increasing energy use of digital technologies. Comments included the following:

"I learned that bitcoin uses as much watts of energy as Denmark."

"We need more sustainable energy use."

"Energy is slowly becoming more inefficient."

Just physics: Students (N=2) recalled some basic science, for example, "Energy is transferred through heat."

Random and abstract: Students (N=2) either remembered an obscure fact or had an abstract thought

"David Thouless got awarded Nobel prize."

"About how different it is"

Question 3. My experience today has changed my understanding about society's use of digital technology.

Nearly all participants (79%) either strongly agreed or agreed that their experience with FLEET at the expo changed their understanding about society's use of digital technology. See Figure 1.

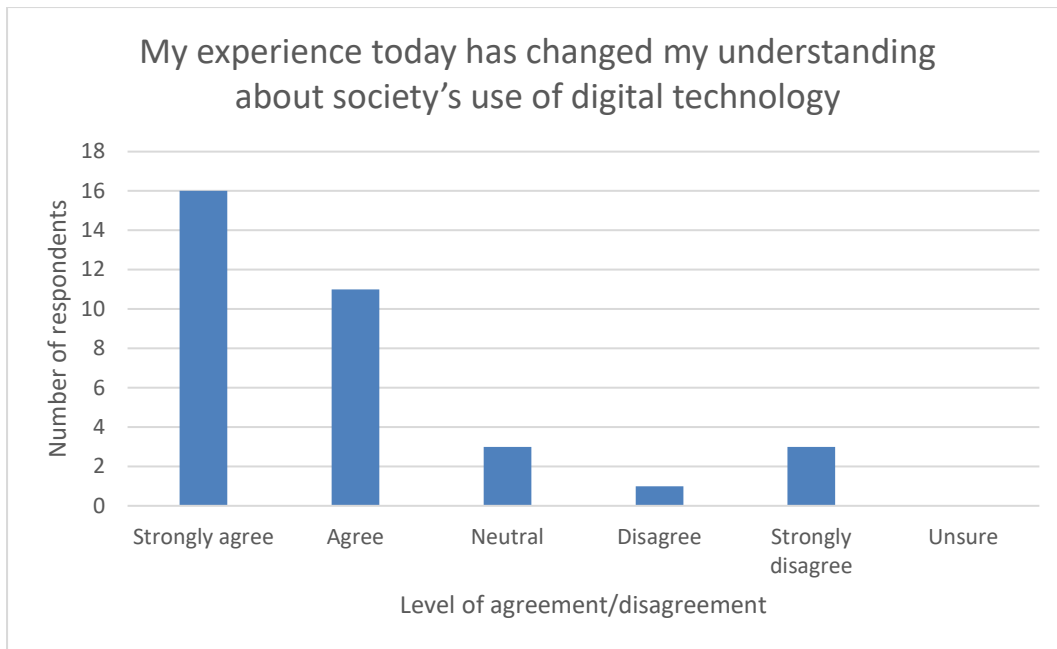


Figure 1. The Sydney Science Trail respondents' level of agreement/disagreement about whether their experience with FLEET changed their understanding of society's use of digital technology

Question 4. Low-energy technologies are unlikely to make a difference to the lives of ordinary people.

There was a varied response to this question with about equal numbers of respondents strongly agreeing/agreeing and strongly disagreeing/disagreeing that low-energy technologies are unlikely to make a difference to the lives of ordinary people. See Figure 2.

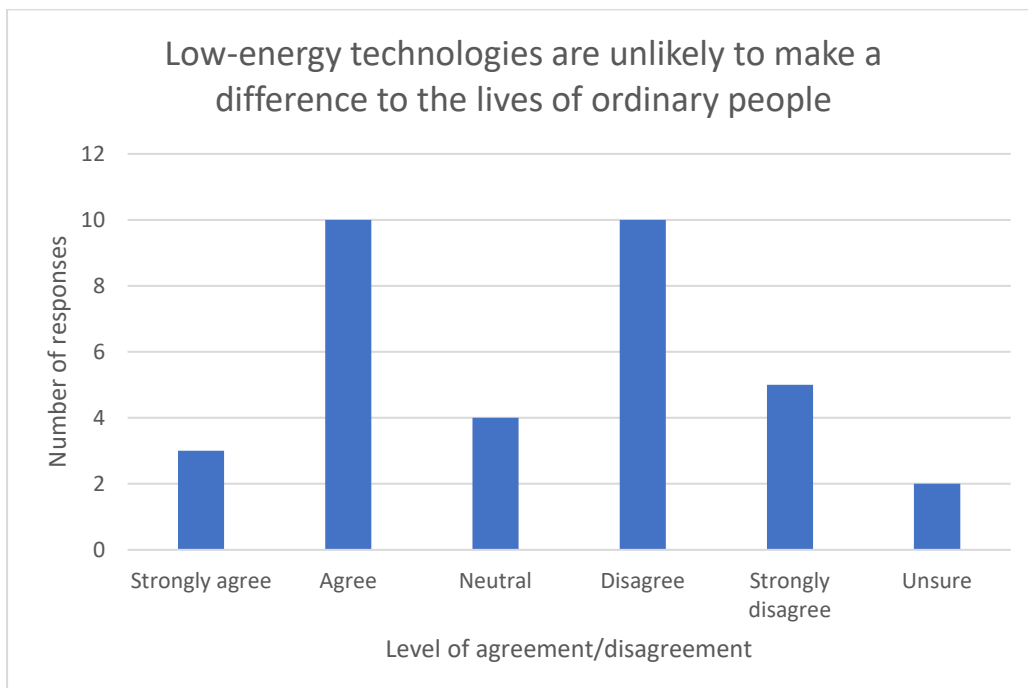


Figure 4. The Sydney Science Trail respondents' level of agreement/disagreement about whether low-energy technologies are unlikely to make a difference to the lives of ordinary people.

Question 5. I am unconcerned because there is always a technological solution to problems such as the energy consumption of digital technologies.

Most responses to this question were either neutral or disagree. There were as many unsure responses as there were those that either strongly agreed or strongly disagreed. See Figure 5. In hindsight unsure and neutral could represent the same to respondents of this question. The terminology for the Likert scales could be adjusted for this question.

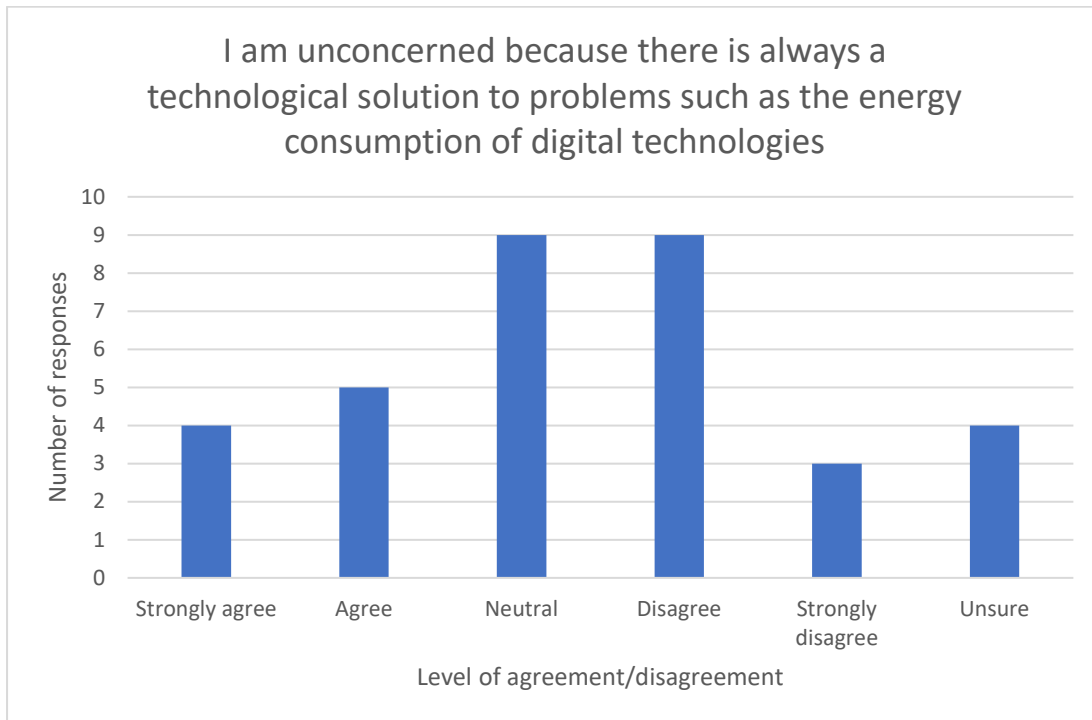


Figure 5. The Sydney Science Trail respondents' level of agreement/disagreement about being unconcerned about digital technology's energy consumption because there is always a technological solution to problems such as the energy consumption of digital technologies.

Question 6. I have a deeper appreciation of research and its value.

Most respondents (62%) strongly agreed or agreed that they have a deeper appreciation of research and its value following their engagement with FLEET. Five people reported being neutral. Only 5 (15%) strongly disagreed or disagreed with this statement. See Figure 6.

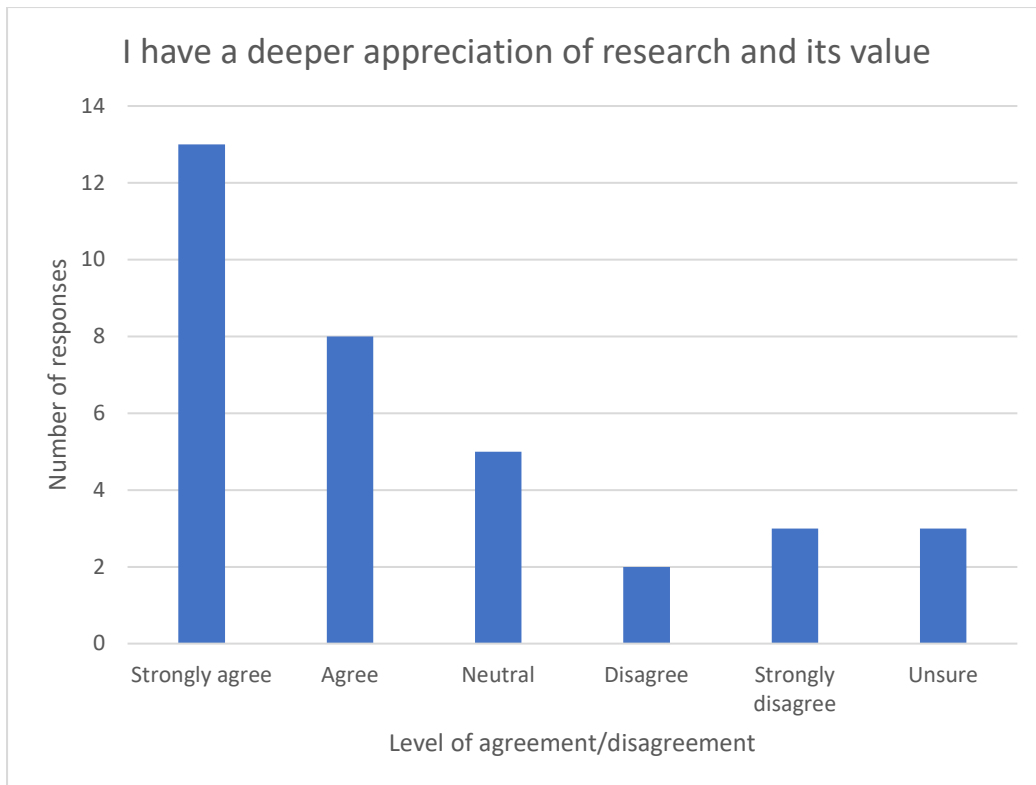


Figure 6. The Sydney Science Trail respondents' level of agreement/disagreement about whether they have a deeper appreciation of research and its value following their visit to the FLEET exhibit.

Volunteer survey

All FLEET members (N=4) that responded to the survey noted that the levitating superconductor was a drawcard and helped them engage the public about FLEET research. The four responses to the survey provided insufficient data for strong themes to emerge. Two of the themes, however, reflect similar themes that emerged from the data in the Melbourne Knowledge volunteer survey: Enjoying conversations, connecting; and Sci Comm skills. These two themes and a third (Knowledge sharing) that was based on responses from one member only are outlined below.

Enjoying conversations, connecting with the public.

FLEET members felt that the outreach at Sydney Science Trail gave them a connection to the public through their enjoyment of simply chatting to people about FLEET research.

"It's always fun to chat to high school students in particular and draw the link from the fun parts of science (magnets, cryogenics, etc) to computers."

"I enjoyed the communicating rather abstract concepts related to cutting edge research to a young audience with the help of the superconductor levitation experiment."

For one FLEET member this connection and engagement with the public made them feel valued and proud.

"Good to see a 10-year old boy asking me about Field theory. The fun part of the experiment - if I was able to run the superconducting material on the Mobius track then the excitement on people's faces was priceless, felt like a proud moment."

Sci comm skills

FLEET members valued the outreach experience because it enabled them to practice communicating complex concepts to different audiences. For one member it even helped their own understanding of the topic.

Going through the motions of understanding type 2 superconductivity, which is pretty involved grad level quantum physics, and finding a way to explain it simply was useful for my own understanding of the topic.

I practiced my skills to explain scientific concepts.

Two members, however, were explicit in their perceived value of developing effective communication skills

As a scientist, I believe it is crucial to be able to articulate your research clearly and convey its significance to audiences outside of your discipline. As a result, effective communication is of the highest significance

I believe these skills are crucial for professional scientist to successfully contribute to society

Knowledge sharing.

This is based on the responses from one FLEET member only who found the outreach experience helped her find a sense of purpose in sharing their knowledge with others.

I take great pleasure in sharing my knowledge with others, particularly young minds. The kids and students are more enthusiastic and engaged, and you have a greater sense of purpose as an instructor.

Impact

The evaluation was conducted with secondary students only with an average age 14.4 years. There was a limited time frame the students were given in the Expo, which constrained the depth of conversations FLEET members could have with them. The evaluation also only occurred on the first day of FLEET's presence at the Expo. We lack data from the other three days FLEET attended the expo, including the day open to the public. Our understanding of the event's impact is therefore limited.

The limited engagement time means that student responses to the survey lack strong context. That is, with the exception of a few, students spent less than five minutes at the FLEET exhibit before attempting the survey, most of that was spent watching the levitating superconductor demonstration. Some students, as noted in the Reflection section below, started the survey before any engagement with the FLEET exhibit. Therefore, student responses will be largely based on their own experience and intuition rather than any critical thinking about what they saw or discussed with FLEET members. The survey analysis might, however, be considered an insight into 14-year old students' interpretation of scientific research and the role of science, and their values relevant the energy use of digital technology. Despite the limitations I have attempted to draw some meaning from the student survey data. Following this is an analysis of the FLEET volunteer survey data.

Survey analysis

There is what appears to be a contradiction in the data between question 2 that asked students to recall one thing they learned from the experience and question 3 that asked whether the experience had changed their understanding about society's use of digital

technology. Students' recollection of what they learned is largely a vague and often incorrect understanding of the levitating superconductor. Only five students recalled something relevant to how society uses digital technology. This contrasts with the findings in question 3 where nearly all students either strongly agreed or agreed that their experience with FLEET at the expo changed their understanding about society's use of digital technology. We did have posters up with facts relevant to the increasing energy consumption of digital technologies and one FLEET member noted that some people did read the posters and comment on them. This may help explain the students' perceived change in understanding of this problem, though this is speculation only. This contradiction makes it difficult to draw any conclusions about whether students' experience with FLEET made them think critically about how society uses digital technology.

As noted, there was minimal dialogue with students about the problem of energy consumption of digital technologies. It is likely students' responses to questions 4 and 5 are based mostly on their own experience and intuition.

There appears to be a varied interpretation of the value of low-energy technologies that leaves one begging to understand more about what underpins this thinking. Do students understand what is meant by low-energy technologies? If they do, what underpins their perception that low-energy technologies will or will not be of value?

In question 5, while the majority of responses were either neutral or disagree, there were still a large number that agreed or strongly agreed that technology will always provide a solution to problems such as the energy consumption of digital technologies. This suggests that a significant portion of this cohort have optimism bias and perceive that we need not be concerned because technology will fix any problem. A large portion were also unsure, which as noted above, could also be considered a neutral response. This might suggest some degree of critical thinking, but again this is speculation. This is where the supportive data from the mind map and observation notes would have added more depth to understanding what is happening here.

While it is encouraging that responses to question 6 suggest that students have a deeper appreciation of research and its value following their experience with FLEET, the limitations noted above again make any conclusion speculation.

Volunteer survey analysis

Despite only four volunteers responding to the survey, two themes seem to be emerging when this data is combined with volunteer survey data from the similar Melbourne Knowledge Week event. These two themes are, Connecting with the public and Sci Comm skills. The former was a strong theme in the Melbourne Knowledge week data for 2021 and 2022.

The connection volunteers make with the public is a palpable connection facilitated by the public's genuine interest in the volunteers' research. This seems to make volunteers see a greater purpose and value to their work. The science communication skills they build from the experience is valued with most volunteers being explicit in the level of importance they place on their ability to communicate effectively with different audiences.

Meeting FLEET objectives

The limitations of the data make it unclear whether we achieved a greater appreciation and awareness of the purpose and value of FLEET research and physics, though question 6 is suggestive that students at least have a deeper appreciation of research generally following their experience with FLEET.

There is nothing in the data to suggest that we increased public awareness about the increasing energy demand of digital technologies; that we got the public thinking critically about the meaning and value of FLEET research, or that primary and secondary students gained a greater interest in and awareness and appreciation of physics.

The volunteers survey data does, however, indicate that engagement with the public at the expo helped FLEET researchers improve their communication skills and they achieved more understanding of how the public perceive physics and FLEET research.

Reflections

Engagement and dialogue

I acted as floating volunteer on the first day to observe FLEET members and the students visiting the exhibit, and to encourage people to participate in the survey and the mind map. Based on the first day only, the FLEET members talked with students mostly about the science of the levitating superconductor – some were better at it than others. I asked 8-10 students as they left the superconductor demonstration to tell me about what they recalled about the experience and what they learned. The focus of every student's recollection was about the superconductor and along the lines of, cold stuff and things that float on magnets. This is reflected in the students' responses to question 2 in the survey.

I chatted to the FLEET volunteers about this in a break and noted that we need to focus more on the research problem that motivates FLEET research and FLEET's research to try and solve this problem. The levitating superconductor can also be linked back to FLEET research. I also reiterated this in an email that went to the FLEET members participating on the following days. My aim to correct this problem in this way appeared to have been unsuccessful and highlights the need for some training of volunteers before such events and for the outreach coordinator to be present to help volunteers for the duration of the event.

Survey

Regarding the survey, I noted that students were often scanning the QR code for the survey and attempting to do the survey before even engaging with FLEET members or watching the levitating superconductor demonstration. I had to intervene and ensure they first asked at least one question and watched the demonstration before attempting the survey.

One FLEET member's feedback was that we need to have a link to the FLEET website on the survey. This is a good idea and an oversight on my part. In addition, it would be good to develop a poster for FLEET schools with a QR code to the FLEET Schools website. This was done for the CONASTA science teacher conference and something similar could be adapted for public events.

For question 2 in the survey, Write one interesting thing you remember from your experience with FLEET.

A better question might be, Tell me about something from your experience with FLEET that made you think. We also need to reconsider the Likert scale categories for question 5.