

Getting it on the Table: Using Diagrams and Graphs within an Interview

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'Articulate science: Re-thinking the school education of prospective scientists' investigates the relationships between Australian professional scientists and the broader community. Data production for 'Articulate Science' was by a one-to-one semi-structured interview in which the participant was asked to draw a variety of sketch graphs and diagrams as he or she elaborated on aspects of their development as scientists. The use of these diagrams and graphs proved successful. We explore some of the ways in which they were used by participants and researchers during the interview. We give examples of participant responses and feedback about the interview.

Background to the Study

A key motivation for this project was to understand how a school science curriculum could better represent the work of scientists today. The project had its origins in a theoretical argument made by Smith (2006), that contemporary science and society were intertwined to such an extent that the needs of future Australian scientists were not entirely met by the traditional academic science curriculum that is typical of Australian secondary schools. Contemporary science offers a significantly wider range of models for scientific work and modes of knowledge production that, if included in the curriculum, might potentially offer a greater range of entry points to science for all students.

Purpose of the Study

This study focused on scientists whose work brought them into contact with the public. It aimed to:

- map the nature and extent of contact that scientists who interact with the public in their work had with various sectors of the public;
- understand how these scientists develop the capacity to carry out these interactions;
- understand the extent to which scientists perceive that their work as scientists entails developing a relationship between them and society in the broad, and investigate the manner in which they form and shape such a relationship;
- investigate the role, if any, that their own school science education played in their recognition of such a relationship and in the shaping of their perception of it. A particular focus, here is on the links, if any, between the accounts given by scientists

of their schooling, its role in the development of their own personal sense of social responsibility and features of contemporary school science curriculum.

The intended outcome was to:

- develop some principles that can inform the secondary school education of intending scientists, and consequently
- improve the school science education of all students.

Design of the Study

The research was designed as a case study. It involved 36 scientists, from six Australian states and territories, all of whom were invited to participate because we had reason to believe their work as scientists brought them into contact with various groups of non-scientists.

Within this 36 there were three categories of participants:

1. Ten were scientists who are prominent in society for their scientific and community work (as identified through their media profile, through relevant community organisations, and from other public recognition). This group was selected because of an interest in scientists who have by their own actions challenged the dominant public image of the detached academic scientist.
2. Seventeen were scientists whose work brings them into contact with the public, but whose public profile is largely a consequence of their work; for example, forensic scientists, bushfire researchers, agricultural scientists/soil scientists who deal with farming communities.
3. Nine were academic scientists who teach first year subjects in the tertiary sector. This group was included because of their power to inform the image that secondary school science teachers form of science and scientists.

All participants are actively engaged in research, although three of the academic scientists now see themselves as science education researchers and one academic scientist now also does research in science communication.

The case study methodology allowed us to engage with the participants to some depth, and each participant was interviewed for between 90 and 120 minutes. It was important that the interview allowed the participants as much freedom as possible to set the agenda and provided the interviewer with a view of the possible avenues to explore. Accordingly, the interview was semi-structured (Robson, 2002) and included questions in which diagrams and sketch graphs were used to elicit responses and provide a basis for further discussion of issues. It is these diagrams and graphs that are the focus of this paper.

The nature of the interview and participants (all scientists) required experienced interviewers with knowledge of science and of science education. Hence, each scientist was interviewed by a researcher who had an undergraduate science degree as well as experience in science teaching and science education research.

The Interview Protocol

At the beginning of the interview, each participant was asked to complete an information sheet that provided basic demographic data about their education and work background as

well as any academic qualifications. Many participants described their careers as they completed this information sheet, and many asked us questions about the level of detail they should provide. It is likely that this document broke the ice by allowing the interviewee to be the person asking the questions.

The formal part of the interview began by presenting the participant with a copy of the Star Chart shown in Figure 1 and asking them to fill in as many segments as they could to show the various groups with whom they interacted during their work as a scientist. This question ‘got onto the table’ for both participant and interviewer the range of relationships that would form the basis for the rest of the conversation. It was not uncommon for additions to be made later in the interview as another group was remembered. Once the groups were on the chart, participants were asked to number them to show the order in which they first began to interact with each group.

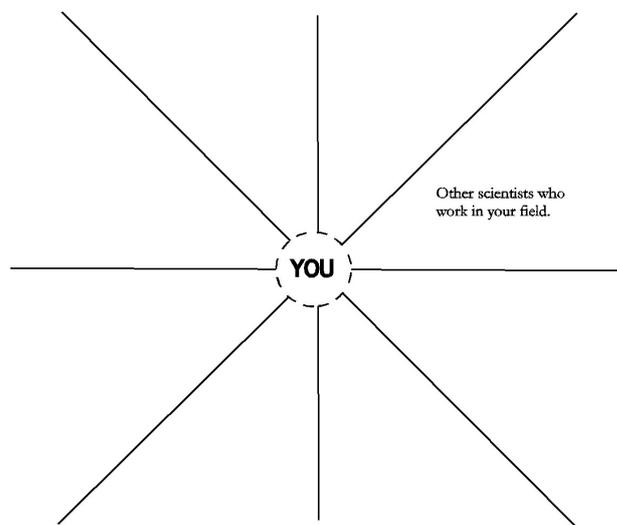


Figure 1: Question 1 Star Chart

In Question 2 the participant was handed a pre-drawn set of axes, asked to choose two or three of the groups identified on the Star Chart, and to draw a graph to indicate how their ability to interact with that group had developed over time. Similarly, in Question 3 the participant was handed a pre-drawn set of axes and asked to draw a graph to indicate how their awareness of a need to engage with the public about their work had developed over time. For Question 4, the interviewer filled in the table shown in Figure 2, classifying the various groups on the Star Chart as ‘scientific’ or ‘other’ on the basis of the comments made by the interviewee. The participant assisted in this task, clarifying, if necessary, which column was appropriate for the individual groups. The participant was then asked a series of questions about the attitudes, competencies and skills that the people in each column needed to enable a productive conversation with those in the other column.

| Scientific Groups | Other Groups |
|-------------------|--------------|
| | |

Figure 2: Diagram for Question 4

Finally, Question 5 asked about the participant's experience of school science. Question 6 was asked of academic scientists only; it explored their teaching intentions for their classes.

How Participants and Researchers used the Diagrams and Sketch Graphs

We comment mainly on the use of the Star Chart in the interview protocol.

Many participants spent a significant time thinking before commencing work on the Star Chart, and for all there were significant pauses while they worked on it. Eventually, we came to expect that the request to complete the Star Chart would trigger deep consideration. Most participants completed the Star Chart chronologically, and as they filled the segments they would talk about the various groups with whom they had interacted throughout their professional lives, with some participants describing interactions that dated back to their school days.

Once the chart had been completed it lay on the table as a reference point that both the participant and interviewer would refer to for clarification, and to guide the subsequent interview. The sketch graphs drawn for Question 2 deal with groups that were listed on the Star Chart, as does the table drawn for Question 4.

Bagnoli (2009), drawing on the work of Eisner, reminds us that not all knowledge is reducible to language. The choice to use graphs and diagrams in the interviews was partly motivated by a hypothesis that our participants were likely to have a tendency to use diagrams in their professional lives (Crilly, Blackwell, & Carson, 2006). What is apparent now is that the Star Chart provided a frame for what our participants did not have readily available in their minds (Thygesen, Pedersen, Kragstrup, Wagner, & Mogensen, 2011). Our request that they write down the groups with whom they interacted brought our agenda to the table in a tangible form. Participants had a degree of freedom to shape their response in the ways that suited them, and in turn this response then guided the subsequent interview.

The sketch graphs that were subsequently drawn in Questions 2 and 3 provide elaboration of a different type. What is significant in diagrams of this type is a change in the gradient of the graph (Beijaard, van Driel, & Verloop, 1999; Feteris 2008). For our participants these changes indicated a significant alteration in their ability to interact with a given group or awareness of the need to engage with the public. In many cases, drawing the graphs prompted the participants to discuss particular significant experiences or events in their lives. While the participants also took time with the graphs, in comparison with the Star Chart they were produced relatively quickly. We suggest this is because much of the thinking and remembering had been done already in the Star Chart.

Participant Response

Several of the participants told us that they enjoyed the interviews. Certainly, they were very generous with their time, and several seemed quite reluctant to have the interview end. As Carl put it, the interview “got them started”. Prescott found the experience so rewarding that he wanted us to interview his whole department.

More than one participant remarked that they found the interview interesting. As Sam said, “Oh, you pose some interesting questions!” We suggest that the tasks provoked them to think about their experiences in new ways. The extended excerpt below of the interview with Maurice gives a sense of this:

Maurice (after drawing a sketch graph in Q2 of his ability to interact with scientists):
... And the scale isn't really that big ... [here's] the mathematician coming in ...
'non-linear scale' (writes this next to horizontal axis of Q2 sketch graphs).

Interviewer: Yes.

Maurice: [Laughs.] Okay. So I would [draw a graph for] NGOs next. Now let me think ... okay. I would say, ah, there was some interest ... they're not ... the heights are going to be not related.

Interviewer: That's okay, that's okay.

Maurice: So there was some interest in the beginning, but let's say it went a bit like this ... and then ... now after that, there were periods. ... So it will be more up and down, okay? So I'll just do a symbolic kind of thing [draws a rough step function]. Alright, it's just ... So this will be NGOs [labels sketch graph accordingly].

(Further discussion as interviewer clarifies what Maurice means by “interest”.)

Maurice: Um, okay. Media is probably an important one. So after that ... well there would have been nothing, and then media would have started after that too. Oops (drawing on Q2 axes). Okay. Now again, it would have plateaued. It would have oscillated, um, but you don't want the oscillations really ... you want the ability...

Interviewer: No, it can be an oscillation... oh, I see...

Maurice: Oh well I'll just do it like this. Ah, media (draws a rough sine curve and labels graph on Q2 axes, and discusses his experiences with the media).

For the majority of our participants the task of drawing graphs was both familiar and thought provoking and enabled them to represent their experiences with a greater degree of precision than was available in a more traditional interview.

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