Chapter 9

TOWARDS AN ALTERNATIVE FRAMEWORK FOR MAPPING SCIENCE COMMUNICATION ACTIVITIES

9.1 INTRODUCTION

This thesis has considered the impacts of five different science communication activities, aimed at different audiences and held in different venues. In order to make any form of comparison between the activities, they must be placed in a framework relative to one another. One appropriate framework consists of the two axes described in Chapter 1, corresponding to ***target audience*** and ***venue***. Limitations of these axes were discussed in Chapter 8. In addition, these axes would not necessarily be appropriate for many of the other science communication activities that take place in the UK. For this reason, it was decided explore axes that may be used to map a wider range of science communication activities. Mapping exercises have been conducted before, for example as part of the Wellcome Trust/OST study '*Science and the Public'* (2000), although the axes presented in this chapter reflect few of the same criteria, so could be considered a complementary approach to mapping activities.

Why map activities?

There are a number of potential benefits to science communicators of placing an activity on a particular axis or map. Firstly, the exercise of placing the activity on the relevant axes would assist in the clarification of the activity aims. Secondly, it would allow other activities in a similar genre to be identified, and good practice and learning from previous similar activities would assist in maximising the impact of the new activity. Thirdly, guidance on evaluation strategies for different types of activity already exists, for example RCUK/OST '*Evaluation: practical guidelines'* (2005), and accurate mapping may allow the most suitable evaluation strategy for the activity to be identified and implemented at an early stage in the project.

9.2 DIMENSIONS

The ranking exercise detailed in Appendix 9.1 was conducted with a colleague in the science communication field. This allowed discussion of the relative positions of the activities. A number of possible dimensions were considered in the context of 25 diverse science communication activities, including the ones evaluated in this thesis, some that one or both of the researchers had evaluated, and others chosen to provide as diverse a range of activities as possible.

The activities were assigned relative positions within each dimension by considering the relative positions of activities from the perspective of a member of the activity's target audience. The ***level of audience engagement*** dimension considered the maximum level to which an audience member could engage in an activity, and the minimum level of engagement that would be required to consider an individual to be engaged in the activity. The ***avoidance*** dimension described the ease with which a disinterested potential audience member could avoid an activity. Typical levels of audience engagement were considered within the ***intensity of experience*** dimension. ***Potential audience size*** and ***activity reach*** were also dimensions that were considered. In addition, ***topicality of scientific content*** and ***direction of knowledge/information transfer*** between specialists and non-specialists were included. It is important to note that the criterion for the selection of a dimension was that it must not judge the value of the activities within it. In other words, the positions are not an indication of one activity having a greater value than another; a scientifically literate society will be one that encourages a range of different science communication activities with a variety of aims and messages. A number of factors were found to contribute to the relative position of activities within each of the dimensions explored, and emerged as categories of activities within each dimension. For example, level of choice in attending an activity was found to be a factor affecting the position of activities within the ***avoidance*** dimension. These emergent factors were used to form axes, which, when combined, can produce a framework into which science communication activities can be placed.

It is important to note that each activity was considered from the perspective of a member of its target audience. Adopting this audience perspective allowed diverse activities aimed at different audiences to be compared within the same dimension, but also led to some limitations of the axes, as described in Section 9.3.2. The activities used in the exercise (including the activities evaluated in this thesis) and their relative positions within each dimension, are given in Appendix 9.1.

9.2.1 Engagement dimension

Maximum level of engagement

Within the engagement dimension, maximum and minimum levels of audience engagement were considered. Maximum level of engagement with an activity was defined as the experience of an individual who was offered (and took) every possible opportunity to engage with the activity. Whether the engagement was with scientific or issues-based material was not distinguished. Figure 9.1 shows the emergent categories and their associated activities.

Figure 9.1 *Categories for maximum level of engagement in an activity*

Category	Types of activity
Highest maximum level of engagement	
Activities where the content is decided by participants	Competitions involving entrants preparing material
Activities which allow engagement over a long period	Planet Science, sign-up email resources for teachers
Immersive activities involving prescribed roles	Role-play activities such as the Challenger learning centre
Dialogues and debates - more than one opportunity to engage	Science Festivals, dialogue activities such as the Royal Society dialogue programme, Science Cafés
Dialogues and debates - one-off opportunity to engage	Dialogues and debates, pub quizzes, consultations
Participatory activities	Science Discovery Centres
Activities that involve human interaction	Role model schemes, science busking activities
Presentations, small audience contribution	Demonstration lectures, live presentations
Interactions with media – some feedback mechanisms	Science publications (with feedback pages), poster schemes with text or other feedback
Interactions with media – no feedback mechanisms	Television/radio documentaries, poster campaigns, websites, computer games
Lowest maximum level of engagement	

The order in which the test activities were placed is given in Appendix 9.1 (page 280). There are a number of factors interacting to decide the position of an activity within this dimension. Firstly, it was assumed that activities where the content is decided by the participants would mean a high level of engagement, since time and effort are required to prepare the material for competitions such as CREST, where students present a scientific project, or FameLab, where entrants deliver prepared presentations. Activities such as school science fairs where students present a science project are another example of an activity in this category. Secondly, the amount of time over which engagement is possible was an important factor. Planet Science, which ran for a year, potentially offered a greater level of engagement than a science festival which runs over a few days or a week. Thirdly, the extent to which an activity is dialogical or discursive was important, and the inclusion of dialogue gave an activity a higher relative position. Participatory activities were defined as those which allow participation and one-on-one interaction between specialists and non-specialists, but not as a primary objective. The NOISE role model scheme, which involves media activities and presence at events such as science festivals, is an example of such an activity. Activities which involved live presentations of science, but where audience participation was limited (such as demonstration lectures) were positioned next on the scale. Finally, interactions with media were seen as having the lowest maximum level of engagement – those which allowed some level of feedback (such as the text response facility for poster campaigns such as SciBus or the letters page of New Scientist) were positioned above those which had no formal feedback mechanisms.

Because this scale considered maximum level of engagement, it does not take into account the handling of an individual’s choice to engage. Factors contributing to this choice are: ways in which audiences are targeted or recruited, level of event facilitation and the activity venue. These factors were included in the next exercise, which considered minimum level of engagement.

Minimum level of engagement

Minimum level of engagement was defined as the minimum an individual could do and still be considered as engaged in the activity. It was important to consider this as well as the maximum level of engagement since for some activities the two levels of engagement are the same, while for other activities there is a marked difference in maximum and minimum engagement level. The categories identified and their descriptions are given in Figure 9.2.

Figure 9.2 *Categories for minimum level of engagement in an activity*

Category	Types of activity
Highest minimum level of engagement	
Activities where the content is decided by participants	Competitions involving entrants preparing material
Structured activities involving prescribed roles	Role-play activities such as the Challenger learning centre
Heavily facilitated discussions – zero-choice contribution	Structured dialogue activities, focus groups
Dialogues and debates – free choice contribution	Discursive or dialogue activities with some facilitation
Zero-choice presentations, interactives	Activities held in schools or where school groups are obliged to attend
Media – non-intrusive	Media that audiences would choose to engage with, e.g. Television documentaries, magazines
Media – intrusive	Media that audiences are presented with, e.g. in a generic venue, e.g. poster campaigns in schools or on buses
Lowest minimum level of engagement	

The order in which the test activities were placed is given in Appendix 9.1 (page 281). Choice became an important factor in the positioning of activities according to minimum level of engagement, and the nature of the choice to attend an activity and the choice to contribute to an activity were distinguished. Where attendance is '*free-choice*' the minimum level of engagement is higher than where it was '*zero-choice*', since making the effort to attend an event or use a form of media constitutes a greater level of engagement than where audience members have no choice in the matter. As with the previous scale, the competitions, where participants are in control of the content of the activity, had the highest level of minimum engagement. Directly following these were activities that are very structured or heavily facilitated, offering audience members no choice as to whether or not they can participate. In events where contributions are free-choice, the level of minimum engagement is lower as audiences can choose to 'opt out' of the discussion. Similar events held in generic venues or for school groups had a lower level of minimum engagement since these events are '*zero-choice attendance*'. Interactive activities were positioned lower as the audience is not considered captive, and media were positioned below these, as the effort to visit a Museum or Science Discovery Centre was deemed greater than the effort required to look at a poster or website. In the final two categories, media were distinguished as intrusive and non-intrusive. Non-intrusive media were defined as media where the choice to engage was made by the audience, for example by watching a documentary, or reading a book or magazine. Intrusive media, on the other hand, were '*zero choice*', and would include posters in schools or on buses.

The minimum level of engagement was assessed assuming that, for most of the activities, an audience member would still need to make the choice, for example, to attend an event, watch a television programme or look at a poster. This does not take into account how actively participants are recruited, or fully explore the implications of the type of venue in which an activity is delivered. For this reason, a further dimension was proposed to consider the extent to which an activity could be avoided by its target audience.

9.2.2 Avoidance dimension

Within this dimension, activities were ranked by the ease with which they could be avoided by members of the target audience/s who had heard about the activity; so the assumption was that the activities had been effectively marketed and promoted. The categories and their descriptions are given in Figure 9.3.

Figure 9.3 *Categories for potential avoidance of an activity*

Category	Types of activity
Most difficult to avoid	
Zero-choice attendance, zero-choice participation	Activities such as the Challenger learning centre
Zero-choice attendance	Events for school groups
Generic venue activities – live presentations	Activities held in generic venues such as pubs or supermarkets, science busking
Generic venue activities – media	Posters in schools or on buses
Free-choice attendance -active targeting of audiences through outreach or direct recruitment	Activities involving outreach e.g. Planet Science or Edinburgh Science Festival, or direct recruitment such as Cybertrust
Free-choice attendance - multimedia activities	Activities using more than one medium to communicate their message/s
Free choice attendance - single medium activities	Activities using a single medium (excluding live events)
Least difficult to avoid	

The order in which the test activities were placed is given in Appendix 9.1 (page 283). Zero-choice attendance activities were felt to be most difficult to avoid, and activities such as the Challenger experience at the National Space Centre, where participants are assigned a specific role, were placed at the top of the scale as participation is also zero-choice (although it is arguable whether this means the activity is more difficult to avoid). Activities in generic venues, where the audience do not choose to attend the science event, are also reasonably difficult to avoid, although engagement in the activity is at the discretion of each potential audience member. In this instance, activities involving live presentations and busking would be more difficult to avoid than posters or other media. Following these, activities where audience members have free choice over whether to attend were considered. Activities where efforts beyond ‘standard’ activity promotion were made to recruit audiences were deemed more difficult to avoid, for example in the case of Planet Science, where much outreach work was undertaken, or the Cybertrust dialogue, where members of the public were targeted and recruited in the cities where the meetings would take place, and paid for their contribution. The easiest activities to avoid were those that targeted audiences in traditional ways, or were media-based: where audiences must choose to visit a science festival, read a magazine or watch a documentary. It was felt that activities which employ a number of media, such as NOISE (which uses the web, role models, and broadcast and print media) are more difficult to avoid than those which are based primarily on one or two types of media.

Following the consideration of the three scales described above, a dimension of typical intensity of experience was explored.

9.2.3 Intensity dimension

This dimension aimed to explore the intensity of experience of a typical audience member for each of the activities. It was assumed that intensity of experience would be related to the impact of the activity. However a dimension for activity impact was not constructed in the current exercise as it was felt that such a scale would constitute something of a value judgement of the activities under consideration. The current scale combined the considerations of the previous scales regarding engagement and avoidance. The categories and types of activities are given in Figure 9.4.

Figure 9.4 *Categories for typical intensity of experience*

Category	Types of activity
Most intense experience	
Zero choice, expected contribution	Activities with audience-driven content, heavily facilitated dialogues, role-play activities
Discursive or one-on-one interactions, free choice contribution	Activities with more than one opportunity to engage, e.g. science festivals School activities involving visits, science cafés Facilitated, participatory activities held in schools Role model schemes
Presentations, low-level interaction, contribution not expected	Science busking, demonstration lectures
Media – free choice contribution (low level)	Magazines with letters pages, poster campaigns with text feedback
Media – zero-choice non-contribution	Books, television documentaries, computer games, websites
Least intense experience	

The order in which the test activities were placed is given in Appendix 9.1 (page 283). Since this scale is a product of the three previous scales, it displays features of each. The idea of choice is again important in the relative positions of activities. Zero-choice contribution activities are placed higher than those for which audience contribution is a free choice. Low level contribution activities are placed below discursive or dialogue activities on the scale. This ranking could be considered arguable; a book or television documentary that strikes a chord with its reader or viewer lead to a greater intensity of experience for that individual than attendance at an informal discussion event. This is not disputed; however, it would not be considered a ‘typical’ response in this context. Indeed, it has been assumed that interaction with other people or live presentation of science by a person would lead to a greater intensity of experience for an audience member. For this reason, and because media-based activities often offer no opportunity for audiences to contribute or shape their content, these activities are at the lower end of the scale for intensity of experience. Of course, the intensity of experience would depend on the amount of time for which an individual was immersed in the medium. It is interesting, yet unsurprising, to note that the activities near the top of the scale with the highest intensity of experience are those which require more resources per audience member. This leads to the idea of potential audience size and activity reach, which are discussed as the next two dimensions.

9.2.4 Audience size and activity reach dimensions

It was apparent while positioning activities along the scales relating to the previous dimensions that the reach and potential audience size of an activity were important factors. For this reason, activities were placed on scales relating to these criteria.

Potential audience size

Activities were positioned according to potential audience size. The descriptions of the categories are given in Figure 9.5.

Figure 9.5 *Categories for potential audience sizes*

Category	**Example activities**
Largest potential audience size	
Print and broadcast media	Documentaries, books, magazines, posters
Online media	Websites, online games
Ongoing accessibility, single location	Science discovery centres
Live presentations – ongoing but sporadic	Demonstration lectures
Live events – extended time/several locations	Science festivals, science cafés
Live events – time-limited	Consultations and dialogue collaborations, e.g. GM Nation
Specific target audience	Resources for teachers
Short-term projects and activities that require a high level of involvement	Competitions such as CREST, activities in pubs or supermarkets, discursive activities
One-off or specialist activities	Discursive activities, dialogues such as Cybertrust
Smallest potential audience size	

The order in which the test activities were placed is given in Appendix 9.1 (page 284). Media-based activities were considered to have the largest potential target audience, with print and broadcast media ranking higher than online media. Science centres were ranked next, as they are accessible throughout the year. Below these came live events and activities, with the timescale over which an activity takes place determining its position on the scale. Below this, the nature of an activity's target audience becomes an important factor. Activities with a specific target audience, for example resources aimed at teachers, are naturally going to reach a smaller number of people than those open to, say, the general public. Finally, activities that require a high level of engagement, or have audience-driven content, and one-off activities were placed at the end of the scale, representing smallest potential audience size.

Activity reach

Activity reach was defined as the geographical area over which the activities were accessible to their target audiences. Figure 9.6 shows the emergent categories.

Figure 9.6 *Categories for audience reach*

Category	Types of activity
Greatest reach - international	
International activities	European poster campaign
National media-based activities	National poster campaigns, websites, national magazines, television programmes
National – live activities	Lecture tours, science cafés, national consultations and dialogues
Regional – live activities, more than one venue	Regional discussion event and lecture tours, generic venue activities
Regional – live activities, single venue	Science centres, visits to research facilities
Least reach - regional/local	

The order in which the test activities were placed is given in Appendix 9.1 (page 284). Positioning the activities within this dimension was reasonably straightforward. Activities such as the European poster campaign were classed as international, and these were followed with UK-based media activities and websites. Although international audiences can engage with these activities, their target audience(s) are from the UK. Live activities were ranked as having a more limited reach, and the number and location of the venues of these activities became an important factor in their positions on the scale. Programmes where events take place in venues all over the country were ranked above those whose venues are distributed over a smaller region, and one-off activities were ranked below those. Science centres were ranked as having regional reach, although this is arguable depending on the nature of the centre; they can draw audiences from all over the UK. It was felt, however, that their reach is less because the onus is on the audience to travel the greater distance.

9.2.5 Direction of knowledge transfer

The next dimension considers the direction(s) in which knowledge is transferred between specialists (scientists, science communicators, policymakers etc) and non-specialists (publics). Specialists were defined as those with specialist knowledge on the scientific or other content of the activity, and non-specialists were those who were not in possession of this information. The positions of the activities is given in Figure 9.7.

Figure 9.7 *Categories for direction of knowledge transfer*

Direction of knowledge transfer	Types of activity
Specialist to non-specialist	Didactic activity. No mechanism for feedback e.g. demonstration lecture, website
	Didactic activity. Feedback collected from non-specialists – no means of dissemination to specialists
	Didactic/discursive activity. Some specialists present so feedback possible but unlikely
Two-way/multiway	Discursive/audience-driven activity. Specialists present, feedback mechanism not understood
	Discursive activity. Formal mechanism for non-specialist feedback
Non-specialist to specialist	Non-discursive activity. Information collected from non-specialists e.g. opinion poll

The activities and their positions are given in Appendix 9.1 (page 285). During the exercise, the nature of the material being communicated was not considered, so activities where the content involved science facts or careers were placed alongside those considering ethics. The categories on this scale appear to run from didactic activities (specialist to non-specialist) through discursive activities (two-way/multiway knowledge transfer) to consultations and opinion polls (non-specialist to specialist). Another scale appears to run parallel to the nature of the activities; the way in which feedback is structured. Where the information moves solely from specialists to non-specialists, there is no facility for non-specialists to feed back their views. These activities could be considered as following the deficit model for science communication. (Gregory & Miller, 1998) At the other end of the scale, where knowledge is transferred solely from non-specialists to specialists, there is often a formal information channel in place, such as the publication of a report following an opinion poll or consultation. In the centre of the scale, where the knowledge its transferred in two or more directions, the feedback mechanisms become less formal. Some activities, such as Small Talk, aim to explore ways of ensuring that the feedback process is effective, and with more work in this area the scale on this axis is likely to evolve over time. Also, as the emphasis for funders continues to shift from didactic to discursive or dialogical activities, it is likely that there will be a greater number of activities occupying the central area of the scale.

9.2.6 Topicality dimension

The next axis aimed to consider the scientific or issues-based content of activities, which was largely disregarded in the construction of the previous scales. Which scientific issues are topical at a given time is of course subject to change, so the relative positions in this case are at best a snapshot of 'hot topics' for early 2005. Descriptions of the categories are given in Figure 9.8.

Figure 9.8 *Categories for topicality of scientific content*

Category	Example topics
Upstream topics	
Will be a need for debate. Little regulation framework	Fusion power
Growing need for debate. Topics already identified through horizon scanning	Information security, nanotechnologies
Present need for debate. Regulation framework under development	Genetic screening, GM crops
Little need for debate perceived. Existing regulation framework	Space science, thermodynamics, robotics
Downstream topics	

The order in which the test activities were placed is given in Appendix 9.1 (page 285). Some of the emergent factors on this scale echo the scale proposed in '*Dialogue with the Public'* (RCUK/OST, 2002). This scale classifies activities into four groups according to their topicality. The groups are described in Figure 9.9

Figure 9.9 *RCUK/OST (2002) controversy/public domain scale*

1. Issues that are currently causing public controversy
2. Issues with a clear potential to cause public controversy
3. Issues where the impact on society is not yet established
4. Issues that are interesting but not controversial

The main difference between the scales shown in Figures 9.8 and 9.9 are the directions of the scales. The scale in Figure 9.8 uses the term 'upstream' to describe topics where the impact on society is not yet established and 'downstream' for issues that are interesting but not contentious (RCUK/OST, 2002; DEMOS, 2004).

Downstream topics typically have a well-developed regulation framework Figure 9.8 places upstream and downstream topics at either end of the scale, with 'hot topics' in the centre. The RCUK/OST scale places the most topical issues at the upper end of the scale, and the least topical at the lower end. Both are potentially useful ways of considering scientific issues.

There are a number of factors combining to give the activities their places within the dimension described in Figure 9.8, which is basically a measure of topicality and as such is itself open to much discussion. Topics where there is a present need for debate can be those that are generating the most media column inches and are high on the agendas of policymakers. They can also be the most contentious issues, possibly for political and economic reasons as well as scientific ones. Of course, what constitutes a 'hot topic' can change rapidly over time, a single headline can catapult a previously non-contentious topic into the spotlight, and there may be a sudden need for debate. Following the publication of the recent DEMOS report, '*See-through science*' (Wilsdon & Willis, 2004), the trend has been to move the debate upstream, to scientific topics identified through horizon scanning, and beyond. However, it is not necessarily only the upstream topics that may suddenly become contentious, new applications of 'downstream' science may lead to a call for new legislation. Robotics is an example of such a topic. For this reason, horizon scanning should take place both upstream and downstream of topics currently under scrutiny.

9.2.7 From dimensions to axes

The construction of the dimensions allowed interesting comparisons to be made between the activities, their audiences and the science they included. The emergent factors from each dimension were then combined to form independent categorical axes. These axes are presented in Figures 9.10 and 9.11.

Figure 9.10 *Summary of emergent axes – engagement, avoidance and intensity dimensions; audience size and reach dimensions*

High maximum and minimum levels of engagement, difficult to avoid, intense experience				**Greatest reach**
Audience contribution	*Level of audience ownership*	*Activity description*	*Intensity / audience size*	*Activity reach*
Zero-choice contribution	Audience-driven content	Zero-choice attendance		International
Structured/facilitated	Discursive or dialogical		Smaller potential audience size	
Free choice contribution	One-on-one interactions	Generic venue	Greater intensity of experience	National
	Live presentations	Active audience recruitment or outreach		
		Free choice attendance	Lesser intensity of experience	Regional
Contribution not expected	Media with feedback mechanism	Multimedia	Larger potential audience size	
Zero-choice non-contribution	Media with no feedback mechanism	Single medium		Local
Low maximum and minimum levels of engagement, easy to avoid, less intense experience				**Least reach**

Figure 9.11 *Summary of emergent axes – direction of knowledge transfer and topicality dimensions*

Knowledge transfer specialist to non-specialist		**Upstream topics**		
Feedback mechanism	*Nature of activity*	*Contentiousness**	*Need for debate*	*Regulation framework*
None	Didactic	Issues where impact on society not understood	Will be a need for debate	Little regulation framework
Feedback collected but not disseminated		Issues with clear potential to cause public controversy	Growing need for debate	Topics identified through horizon scanning
Feedback mechanism not understood				
	Discursive/dialogical	Issues that are currently causing public controversy	Present need for debate	Regulation framework under development
Formal mechanism for feedback from non-specialists to specialists				
Information channel	Opinion poll	Uncontroversial issues	Little need for debate	Existing regulation framework
Knowledge transfer non-specialist to specialist		**Downstream topics**		

** Adapted from RCUK/OST (2002)*

The axes described in Figure 9.10 consider the activities from the perspective of an audience member. The nature of the audience is particularly important for the '*activity description'* scale, which was compiled from the perspective of an individual who is generally engaged in society, but without a particular interest in science. Such an individual is likely to engage with an activity if approached or encouraged, but would not necessarily do so under his or her own initiative.

9.3 DISCUSSION

9.3.1 Application of axes

The framework proposed in this chapter is intended as a starting point for future research in this area, rather than a conclusion. Creating a framework from axes that do not judge the value of the activities positioned along them should enable activities to be objectively described and compared.

Following the publication of '*Science and Society*' (House of Lords, 2000) and its call for a new mood of dialogue, the British Association for the Advancement of Science (the BA) were commissioned to recommend a process for government to support the communication between scientists, publics and policymakers (BA, 2002). Eleven recommendations were made, including:

> *"A detailed and ongoing mapping of science and society activities is provided through an actively managed database, in order to provide high quality, comprehensive and up to date information to the OST and other organisations, and potentially capable of development as a UK-wide information service for the public"*

> *"A range of* [Science Communication] *activities is evaluated, linked to the survey of the public, exploring which activities are most engaging for particular groups of people. This might include evaluation of the*

relative awareness and impact of many small activities to larger national or regional events"

The axes proposed within the current chapter provide an alternative framework in which to map activities, thereby allowing the relative strengths and weaknesses of activities which engage different audiences to be compared. Identifying the position of an activity within the framework will allow greater clarification of its aims and objectives, and will facilitate the selection and implementation of an appropriate evaluation strategy, especially if combined with other resources such as the RCUK/OST publication, '*Evaluation: practical guidelines*' (2005). In this way, information on the impact of different activities can be accumulated, and maps of impacts constructed alongside the maps of activities. This will allow areas of overlap and gaps in provision to be identified by the science communication community.

9.3.2 Limitations of axes

The axes have been constructed from the perspectives of the target audiences for different activities. This leads to several limitations. Firstly, it raises the question as to whether greater value should be placed on an activity that includes audiences who are described as 'hard-to-reach', for example some minority ethnic groups, or socially excluded groups, as opposed to 'attentive' or 'interested' publics. This is an important issue, and the fact that greater effort is required to promote inclusion is not fully accounted for within the axes. Secondly, placement of an activity on some axes becomes difficult as the activity becomes more complex. Cheltenham Festival of Science, for example, has a range of target audiences and includes a large number of different science topics. This makes it difficult to locate an exact position on some scales. For activities such as Planet Science, which was more complex again, the task becomes more difficult still. One way of addressing this problem would be to consider the smaller activities within, for example, a science festival, individually, and use the axes to compose a representation of the festival itself.

9.3.3 Further work

The axes in this chapter have been proposed, but not tested. In order to explore the robustness of the different axes, a useful exercise would be to collect information and evaluation data (where available) for each of the 25 activities used to construct the axes, and map them. It is likely that some axes would be found to be more useful than others, and perhaps that different activities would need to be mapped using different axes, corresponding to the aims and objectives of each activity. Following the mapping exercise, the maps produced could be compared with the resources on evaluation mentioned, and proposed evaluation methods for different positions on the axes compared. Another obvious extension of the work would be to repeat the exercise detailed in this chapter with a different set of activities, to examine whether the same factors emerged. This may allow the identification of further factors that should be included in a mapping framework of this nature, and would highlight areas of potential uncertainty. By providing a robust framework which allows science communication activities to be objectively mapped, individual evaluations can become more meaningful, ultimately leading towards a comparison between different activities and their impacts.

9.4 CONCLUSIONS

Activities and their impacts

Each activity evaluated in the thesis was found to have an impact on the cognitive (knowledge and understanding) and affective (feelings and attitudes) domains of members of its target audience. The day-long visit to a science centre appeared to have a greater impact than those activities delivered over a shorter time period in schools, although the immersive nature of the visit was also likely to have contributed to the impacts measured. The demonstration lectures appeared to have a lesser affective impact. It was unclear how the age or pre-existing attitudes of audiences would affect their potential attitude or knowledge shifts; it could be that younger students are more likely to experience stronger changes in attitude than older students. For public audiences, the activity aimed at 'inattentive' publics appeared to have a positive impact on cognition and affect. The affective impact of the science festival appeared less great, however the audience demographics for the activities were very different, and it was impossible to separate the influences of audience and activity type. The science festival was also found to have a sustained impact, and an impact on some visitors' behaviours.

Axes and mapping

The axes used to map the activities at the inception of the project, activity venue and activity target audience, were found to have certain limitations. Through the consideration of these limitations, the construction of a more robust mapping framework was possible, and the alternative axes developed in this thesis can be used to consider a wider range of activities. Although not without its limitations, such a framework has great potential value for science communication practitioners.

The axes described in Figure 9.10 consider the activities from the perspective of an audience member. The nature of the audience is particularly important for the '*activity description*' scale, which was compiled from the perspective of an individual who is generally engaged in society, but without a particular interest in science. Such an individual is likely to engage with an activity if approached or encouraged, but would not necessarily do so under his or her own initiative.

9.3 DISCUSSION

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The framework proposed in this chapter is intended as a starting point for future research in this area, rather than a conclusion. Creating a framework from axes that do not judge the value of the activities positioned along them should enable activities to be objectively described and compared.

Following the publication of '*Science and Society*' (House of Lords, 2000) and its call for a new mood of dialogue, the British Association for the Advancement of Science (the BA) were commissioned to recommend a process for government to support the communication between scientists, publics and policymakers (BA, 2002). Eleven recommendations were made, including:

> *"A detailed and ongoing mapping of science and society activities is provided through an actively managed database, in order to provide high quality, comprehensive and up to date information to the OST and other organisations, and potentially capable of development as a UK-wide information service for the public"*
>
> *"A range of* [Science Communication] *activities is evaluated, linked to the survey of the public, exploring which activities are most engaging for particular groups of people. This might include evaluation of the*

> *relative awareness and impact of many small activities to larger national or regional events"*

The axes proposed within the current chapter provide an alternative framework in which to map activities, thereby allowing the relative strengths and weaknesses of activities which engage different audiences to be compared. Identifying the position of an activity within the framework will allow greater clarification of its aims and objectives, and will facilitate the selection and implementation of an appropriate evaluation strategy, especially if combined with other resources such as the RCUK/OST publication, '*Evaluation: practical guidelines*' (2005). In this way, information on the impact of different activities can be accumulated, and maps of impacts constructed alongside the maps of activities. This will allow areas of overlap and gaps in provision to be identified by the science communication community.

9.3.2 Limitations of axes

The axes have been constructed from the perspectives of the target audiences for different activities. This leads to several limitations. Firstly, it raises the question as to whether greater value should be placed on an activity that includes audiences who are described as 'hard-to-reach', for example some minority ethnic groups, or socially excluded groups, as opposed to 'attentive' or 'interested' publics. This is an important issue, and the fact that greater effort is required to promote inclusion is not fully accounted for within the axes. Secondly, placement of an activity on some axes becomes difficult as the activity becomes more complex. Cheltenham Festival of Science, for example, has a range of target audiences and includes a large number of different science topics. This makes it difficult to locate an exact position on some scales. For activities such as Planet Science, which was more complex again, the task becomes more difficult still. One way of addressing this problem would be to consider the smaller activities within, for example, a science festival, individually, and use the axes to compose a representation of the festival itself.

9.3.3 Further work

The axes in this chapter have been proposed, but not tested. In order to explore the robustness of the different axes, a useful exercise would be to collect information and evaluation data (where available) for each of the 25 activities used to construct the axes, and map them. It is likely that some axes would be found to be more useful than others, and perhaps that different activities would need to be mapped using different axes, corresponding to the aims and objectives of each activity. Following the mapping exercise, the maps produced could be compared with the resources on evaluation mentioned, and proposed evaluation methods for different positions on the axes compared. Another obvious extension of the work would be to repeat the exercise detailed in this chapter with a different set of activities, to examine whether the same factors emerged. This may allow the identification of further factors that should be included in a mapping framework of this nature, and would highlight areas of potential uncertainty. By providing a robust framework which allows science communication activities to be objectively mapped, individual evaluations can become more meaningful, ultimately leading towards a comparison between different activities and their impacts.

9.4 CONCLUSIONS

Activities and their impacts

Each activity evaluated in the thesis was found to have an impact on the cognitive (knowledge and understanding) and affective (feelings and attitudes) domains of members of its target audience. The day-long visit to a science centre appeared to have a greater impact than those activities delivered over a shorter time period in schools, although the immersive nature of the visit was also likely to have contributed to the impacts measured. The demonstration lectures appeared to have a lesser affective impact. It was unclear how the age or pre-existing attitudes of audiences would affect their potential attitude or knowledge shifts; it could be that younger students are more likely to experience stronger changes in attitude than older students. For public audiences, the activity aimed at 'inattentive' publics appeared to have a positive impact on cognition and affect. The affective impact of the science festival appeared less great, however the audience demographics for the activities were very different, and it was impossible to separate the influences of audience and activity type. The science festival was also found to have a sustained impact, and an impact on some visitors' behaviours.

Axes and mapping

The axes used to map the activities at the inception of the project, activity venue and activity target audience, were found to have certain limitations. Through the consideration of these limitations, the construction of a more robust mapping framework was possible, and the alternative axes developed in this thesis can be used to consider a wider range of activities. Although not without its limitations, such a framework has great potential value for science communication practitioners.

Appendix 9.1

- Results of ranking exercise

Activities included in the exercise

Activity name	Provider	Funder	Brief description
Planet Science	NESTA / British Association / Association for Science Education	DfES	The follow-up to Science Year, Planet Science comprises a website and suite of activities aimed at every school student in England and Wales, delivered by targeting their teachers
GM Nation			A nationwide consultation conducted by government with publics regarding genetically modified organisms
Cheltenham Festival of Science	Cheltenham Festivals	Several	A 5 day science festival comprising talks, debates and interactives
CREST	British Association	Supported by various sponsors	A competition aimed at school students who present a science project to panels of judges in local, regional and national heats
Cybertrust	Royal Society	Royal Society	Part of the Royal Society's dialogue programme, a series of events exploring the views of publics on Cybertrust and information security to inform future policy
Small Talk	BA / RI / Cheltenham Festival of Science/ ECSITE – UK	COPUS grant scheme	A collaboration between a number of science communication providers to co-ordinate dialogue events on nanotechnologies with a view to influencing policy
Meet the Mighty Gene Machine – schools	Graphic Science	The Wellcome Trust	A drama and facilitated discussion for school students designed to stimulate debate over the application of genetic screening – held in schools
Meet the Mighty Gene Machine – Science centres	Graphic Science	The Wellcome Trust	A drama and facilitated discussion for school students designed to stimulate debate over the application of genetic screening – held in science centres
FameLab	Cheltenham Festival of Science	NESTA	A competition to find new talent in science communication, loosely based on a reality TV format
Space Centre visit, including Challenger Centre	National Space Centre	National Space Centre	A visit to the Space Centre including the planetarium show 'The Planets' and the Challenger learning experience
Café Scientifique	Local	Local	Informal presentation and discussion in a café, restaurant or bar venue

Activity name	Provider	Funder	Brief description
UpD8	Sheffield Hallam University		An email update service for science teachers that describes the science behind current news stories for incorporation into lessons
Techniquest			A science discovery centre based in Cardiff
NOISE	Momenta	EPSRC	A role model scheme which uses a website, presence in the broadcast and print media and direct engagement at events such as science festivals to promote science careers to young people
'*Great Balls of Fire'* fusion lecture– in school	Culham Science Centre	Culham Science Centre	A lecture about nuclear fusion aimed at AS and A2 Level physics students, held in school
'*Great Balls of Fire*'fusion lecture – at facility	Culham Science Centre	Culham Science Centre	A lecture about nuclear fusion aimed at AS and A2 Level physics students, held at Culham Science Centre and combined with a tour of the research facility
Planet Arkive	Wildscreen	Several	An online catalogue of endangered species
New Scientist			Popular science magazine
Pub Genius	Graphic Science	COPUS grant scheme	Science-based pub quiz incorporating science demonstrations using objects often found in pubs
Science in the Fast Lane	Graphic Science	COPUS grant scheme/IoP	Science busking at motorway service stations, activity packs were also distributed to children to help alleviate boredom during car journeys
'Science is Cool'	University of Liverpool		A liquid nitrogen demonstration lecture aimed at Year 10 audiences and held in school
Time Twins		Institute of Physics	A simple online game involving time travel
Einstein's Brain	Channel 4		A documentary exploring Einstein's physics and the neurology of genius
SciBus	Graphic Science	European Commission	A poster campaign on buses throughout Europe where audiences could give their opinion on the questions posed by SMS
Dirac Posters	Graphic Science	Institute of Physics	Posters about the work of Paul Dirac for display in schools

Each activity was written on a flashcard, and the cards were used to place each activity within one of the dimensions under consideration, considering the activity from the perspective of an audience member.

Maximum level of engagement

Category	Activity
Highest maximum level of involvement	
1	FameLab / CREST
2	Planet Science / UpD8
3	Space Centre and Challenger visit
4	Cheltenham / Cybertrust / Small Talk / Café Scientifique GM Nation / Gene Machine (school) / Gene Machine (science centre) / Pub Genius
5	Techniquest
6	NOISE / Science in the Fast Lane
7	Fusion lecture (at facility) Fusion lecture (school) / Science is Cool
8	SciBus / New Scientist
9	Time Twins / Planet Arkive Einstein's Brain Dirac Posters
Lowest maximum level of involvement	

Minimum level of engagement

Category	Activity
Highest minimum level of involvement	
1	CREST / FameLab
2	Space Centre and Challenger visit
3	Cybertrust
4	GM Nation Café Scientifique / Cheltenham / Small Talk
5	Gene Machine (science centre) / Gene Machine (school) / Science is Cool / Science in the Fast Lane / Fusion lecture (school) / Fusion lecture (facility) / Pub Genius Time Twins / Techniquest
6	Einstein's Brain
7	NOISE / Planet Arkive / Planet Science / UpD8 / New Scientist
8	Dirac posters / SciBus
Lowest minimum level of involvement	

Potential avoidance by target audience

Category	Activity
	Most difficult to avoid
1	Space Centre and Challenger visit
2	Fusion lecture (school) / Fusion lecture (facility) / Techniquest (schools) / Gene Machine (school) / Gene Machine (science centre) / Science is Cool
3	Science in the Fast Lane / Pub Genius Dirac posters / SciBus
4	Planet Science Cybertrust / CREST
5	NOISE New Scientist
6	UpD8 / Time Twins / Planet Arkive / Einstein’s Brain / Cheltenham / GM Nation FameLab / Café Scientifique / Small Talk / Techniquest (publics)
	Least difficult to avoid

Intensity of experience

Category	Activity
	Typical experience most intense
1	Cybertrust FameLab / CREST Space Centre and Challenger visit
2	Techniquest / Cheltenham / GM Nation / Small Talk Pub Genius / Café Scientifique / Gene Machine (science centre) / Fusion lecture (facility) Gene Machine (school) NOISE
3	Science in the Fast Lane / Science is Cool / Fusion lecture (school)
4	New Scientist / SciBus
5	Einstein's Brain / Time Twins Dirac posters / Planet Arkive
	Typical experience least intense

Planet Science and UpD8 were not included in this dimension – it was felt that the level of involvement in these different aspects of these activities varied so widely it was difficult to define 'typical' involvement. These activities occupied opposite ends of the maximum and minimum level of engagement scales.

Activity reach and audience size

Category	Activity
Largest potential target audience	
1	Einstein’s Brain / SciBus / Dirac posters / New Scientist / Planet Science
2	Planet Arkive / NOISE / Time Twins
3	Techniquest / Space Centre and Challenger
4	Science is Cool / Fusion lecture (school)
5	Cheltenham / Café Scientifique
6	Small Talk / GM Nation
7	UpD8
8	CREST / FameLab / Science in the Fast Lane / Gene Machine (school) / Gene Machine (science centre) / Pub Genius
9	Cybertrust / Fusion lecture (facility)
Smallest potential target audience	

Category	Activity
Greatest reach - international	
1	SciBus
2	NOISE / Planet Science / Planet Arkive / New Scientist / Dirac posters / Time Twins / Einstein’s Brain / UpD8
3	Small Talk / Cybertrust / Fusion lecture (school) / Science is Cool / GM Nation / Café Scientifique / CREST / FameLab
4	Science in the Fast Lane / Gene Machine (science centre) / Pub Genius / Gene Machine (school)
5	Techniquest / Space Centre and Challenger visit / Fusion lecture (facility)
Least reach – regional/local	

Direction of knowledge transfer

Direction of knowledge transfer	Activity
Specialist to non-specialist	Planet Science / UpD8 / Dirac posters / Time Twins / Space Centre and Challenger visit / Einstein's brain / Techniquest / Pub Genius / Science in the Fast Lane Planet Arkive / CREST Fusion lecture (school) / Fusion lecture (facility) / Science is Cool / NOISE / Gene Machine (school) / Gene Machine (science centre) / New Scientist
2-way/multiway	FameLab / Cheltenham / Café Scientifique / Small Talk
	Cybertrust / GM Nation
Non-specialist to specialist	MORI opinion poll*

*activity was added to the list for the purpose of this ranking exercise. It illustrates a one-way non-specialist to specialist knowledge transfer.

Scientific content of activities

Category	Activity	
	Upstream topics	
1	Fusion lecture (school) / Fusion lecture (facility)	Café Scientifique / Cheltenham
2	SciBus / Cybertrust / Small Talk / UpD8	
3	Gene Machine (school) / Gene Machine (science centre) / New Scientist / GM Nation	
4	Einstein's Brain / Planet Arkive / Planet Science / CREST / Techniquest / Space Centre and Challenger visit / Science in the Fast Lane / NOISE / Pub Genius / Science is Cool / FameLab / Dirac posters / Time Twins	
	Downstream topics	