Platform of Local Authorities and Communicators Engaged in Science

Modules used: A1, A2

Science Centre

2012

This is a standardized version of the original case analysis number 10. Specific names and locations have been substituted from the original document number 10 with generic references in order to preserve the anonymity of every participant.

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Abstract

Using the *PLACES toolkit for the impact assessment of science communication*, a case study of the science centre was carried out. The centre, located in a city in the northern part of the country, is one of the two large hands on science centres in the country with a rather typical infotainment approach. Visitors were surveyed through standardized, self-administered questionnaire (n=277) and semi-structured interviews (n=20) with the aim of identifying possible impacts of the visit regarding their relationship with science.

Visitors tended to have a higher than average socio-economic status and a generally positive attitude towards science. The surveys showed that most visitors enjoyed their visit very much. Most did not see strong impacts of the present visit or of previous visits on their lives, but there are some indications of effects on scientific culture, nevertheless:

a. Increased likelihood of people talking about science in their everyday life

b. Increased mental "availability" of scientific perspectives/interpretations in making sense of events and perceptions

c. Informal science learning through information demand induced by the visit.

As the visitors tend to come in family groups –mixed by age, gender and interest in science– science centres help to overcome the possible selectivity in exposition to science based on interest, i.e. family members strongly interested in science motivate the less interested members to choose a science centre as destination of a joint family trip.

Introduction

Founded in the year 2000 and located in a city of scientific culture, close to the university campus, the science centre is the older of the two large "hands on" science centres in the country. The idea to create this science centre evolved in the context of the national preparation for the EXPO 2000. Its realization in the city was made possible by a fortunate constellation of individuals from the city and the local university. While the buildings of the centre are owned by the city and state, it is operated by a company on a commercial basis.

With its extraordinary architecture, the main building shaped like a silver oyster, the science centre has become a landmark of the city. About 260.000 visitors visit it each year. Only 16% are from the state; most came from the neighbour states (65%). The main zone of attraction has a radius of about 150 kilometres, but many visitors travel even longer distances to visit the science centre. The entrance fees are of 16 Euros for an adult and of 40 Euros for a family. Other types of tickets, e.g. season tickets valid for one year, are also available. During the week, school classes on excursion frequently visit it and are offered special programs.

After an extension in 2007, the science centre site consists now of three parts: the main science centre building, a second building for changing special exhibitions, and an outdoor area with a tower as the main attraction. The two buildings are separated by a public street but connected by a transparent tube that bridges the street. Moving between the two buildings for visitors is thus safe and possible without going outdoors. In both buildings there are food courts as well as shops selling science toys, books and souvenirs.

About 250 exhibits and experiments can be explored by visitors in the permanent core exhibition area of the main building of the science centre. Some of the exhibits are bought from providers specialized on the demand of science centres; other exhibits are developed and produced in the centre's own shop (and then also offered for sale to other science centres). Some of the exhibits are displays showing effects and offering explanations, others enable sensory experiences (e.g. a dark room or a sofa simulating the shaking during earthquakes), and some are real "hands on" experiments. The main exhibition is divided into three sections labelled "mankind", "earth" and "cosmos". An additional section "milky way" is for children between 3 and 8 years. The second –newer– building contains a changing special exhibition. At the time of the surveys this exhibition was an impressive visualization of statistical information about a typical life –consumption of different goods, production of waste, number of heartbeats etc. This special exhibition enabled visitors to

become active, making guesses and comparing them with the "real" figures, for example. It even included a psychological demonstration of perception biases when making estimations.

As one of the main science centres in the country with a rather typical design based on an infotainment approach, the centre provides an excellent opportunity to conduct a case study of science centres.

Methods

This case study was carried out after an extended talk with the director of the science centre, its marketing manager and further senior members of its staff. In that talk the "philosophy" and history of the centre was explained to the researcher and the aims and details of the implementation of the empirical work were discussed. Director and staff were extremely cooperative in the conduct of the case study. With the help of the centre's staff, two students who regularly work as freelancers in the science centre were hired as research assistants. They distributed and collected the standardized questionnaires and helped recruiting visitors for the semi-structured interviews conducted by the author.

The reliable identification of "effects" of exhibitions is severely limited by several methodological constraints, such as reliance on self-reports in real-life situations (reference 3). Based on a review of the methodological instruments provided by the *PLACES toolkit for the impact assessment of science communication* it was decided to use modules A1 (semi-structured interviews with visitors) and A2 (standardized surveys of visitors) to analyze the impacts of visits to science centres on the visitors.

Recruitment & sampling of visitors for the surveys

The science centre has a complex architecture. It is located in two buildings with different architectural aesthetics, separated by a public street, but connected by a bridge (actually a kind of transparent tube) crossing the street. There are two main entrances and exits, as well as food courts, and the interviews were conducted in the lobby or in the food courts which –due to the high number of visitors– provided limited opportunities to sit down. The interviews were done on two consecutive days (10-11 April 2012), at the end of the Easter holiday period. The weather during these days was partly rainy thus discouraging outdoor activities; the combination of school holidays and poor weather led to a particularly high number of visitors. During the days of the survey, visitors were informed by posters placed in the entrance area about the survey and asked for their participation.

Recruiting visitors for the interviews, in particular the semi-structured interviews, was not easy as the visitors were mostly exhausted after a typical 3-5 hours visit, and if they had children, these were often impatient. At each exit a research assistant was placed to distribute questionnaires to as many visitors as possible, usually one questionnaire per visitor group, trying to secure variance in gender, age and type of visitor group (with or without children). To apply a systematic random sampling approach was impossible as the visitors tended to enter the lobbies/food courts in bulks. The researcher himself moved

between the exits to conduct the semi-structured interviews. Generally, the visitors tended to respond with sympathy to the requests to complete the questionnaire or participate in semi-structured interviews, but sometimes – because of their impatient children– they declined their participation for understandable reasons. To increase the motivation of visitors to participate in the semi-structured interviews, a voucher of 8 Euros value was offered to be used in the shop of the science centre. This helped to keep older children busy while one of their parents was interviewed. The participants of the standardized survey were not given a reward –except some inexpensive little science toys if they had children.

Semi-structured interviews (module A1)

The guidelines model provided by the PLACES toolkit (module A1) was adapted to the specific situation at the science centre. In general, the wording was modified to be more concrete for the specific context, and of course the guidelines were translated into the national language. Some questions were omitted as they did not apply to the science centre; some were expanded to capture likely effects in more detail. However, the general philosophy of the guidelines model in the toolkit was followed. Two questions about effects of previous visits were asked only in an interview if the interviewee confirmed that he/she had already visited the science centre (or a similar centre) within the last 12 months.

During the two days, 20 interviews were conducted –10 with male and 10 with female visitors. Their age ranged from 12 years (a boy interviewed together with his father) to 69 years. The semi-structured interviews with selected visitors lasted 11 minutes on average. They were recorded and later summarized in writing. One interview partner refused to have the interview recorded; in this case the interviewer took notes of her answers.

Standardized visitor survey (module A2)

The questionnaire was constructed using module A2 of the *PLACES toolkit* as a model. Because of the length of the original module, only the most relevant questions were selected for the survey in order to maintain a high response and compliance rate. The questionnaire was formatted to fit on the front and backsides of an A4 form. It was distributed to the visitors by the two research assistants, located at each exit area, who also provided pens and some little science toys to accompanying child in order to keep them patient while their mother or father would complete the questionnaire. A total of 277 questionnaires were completed by visitors during the two days of fieldwork and used for the analysis.

Results

Semi-structured interviews

Visitors motives and social contexts of visits

Visits to the science centre take place in different situational contexts and are based on different motivations. A part of the visits are motivated by parents' (or grandparents') intentions to let their children have some informal science education. In these cases the visit competes with possible science-related alternatives, such as –in that region– a science centre devoted to the climate and climate change or a botanical garden. Enabling "informal science education" is also the motive why the centre is chosen as destination of excursions of many school classes. (Due to the timing of the survey, visits by school classes are not analyzed.) Some visitors had specifically come to the city from quite a distance to visit the centre. One interviewee came to the science centre following a recommendation by his professor to see a specific part of the exhibit related to his study in geology.

In many cases, the motivation is more general and less science-related though. "Having a good day" or "doing something together with children" was another motive. Several interviewees mentioned that the visit to the centre was a joint side activity of people being guests of friends or relatives living in or close to the city, suggested by their hosts. In these cases it is an important feature of the centre that it offers something for children and adults, for people with more and those with less interest in science. Possible alternatives in these situations, mentioned by the interviewees, are amusement parks, cinema, swimming, walking, climbing or other cultural locations such as museums. For example, a museum of emigrants leaving for the United States from the town of the case study was mentioned as a possible alternative. The choice of the centre compared to such alternatives seems partly dependent on the weather. Although the science centre has an outdoor space for activities for children, it is perceived as a particularly good option when the weather is bad.

Mostly, interviewees said that they had learned about the centre through recommendation by friends or the Internet. In some cases, visitors mentioned that they have come to the science centre following a recommendation by their children, who had been here during an excursion with their school class.

The visit

A typical visit lasted 3-5 hours. Most visitors had walked through all three parts of the whole exhibition (plus the special exhibition) although several

interviewees mentioned that the centre was "too much" for one visit, so they had to come back. Some said that while walking through the whole exhibition they had selectively paid attention and spent time at those parts that they found most interesting, skipping other exhibits. Almost all interviewees liked their visit and were excited about it. Some felt overwhelmed by the sheer amount of information they were exposed to. When comparing it with other science centres they had visited, most rated the one of this case study better. Asked which parts they liked most, different visitors mentioned different exhibits or aspects. There were a few highlights though which were mentioned several times such as the "dark room" or the earthquake simulation. The special exhibition was particularly often mentioned when praising the visit. The diversity of exhibits was seen as a very positive feature.

There were few critical remarks. Some mentioned that they no opportunity to do things they would have liked to do because of too many other visitors. Some adults felt disturbed by small children whom they considered too young for the centre. Some commented critically on the noise level and the general darkness/missing daylight in the exhibition. An interesting critical remark was made by a young woman emphasizing the cognitively "demanding" character of science. She said that portraying science as a playful endeavour in the science centre would actually deceive the visitors about its true character as hard work. One visitor made a critical remark –comparing this centre with another science centre– that the exhibits only describe phenomena but do not explain them.

Perceived regional impact of the science centre

Most interviewees didn't have a clear opinion and had difficulties in elaborating their thoughts on that topic. The science centre is mainly seen as another tourist attraction for the city. The image of the city is perceived as being branded by its history. However, a few of the remarks about the regional impact mentioned a strengthening of its image as a town related to technology and science.

Visitors' perception of science

The implicit concepts of science held by the interviewees can be distinguished into two main versions:

1. Science as a problem-solver, safeguard of the modern lifestyle and source of technological progress

2. Science as a producer of knowledge of an educational and enlightening nature

Interviewees seeing science through the utilitarian lens of benefit, point to its function as problem-solver (e.g. energy conservation, new energy sources)

and provider of technologies supporting a modern life-style (e.g. cars, motors, mobile phones). Those holding a concept of science being of importance to education and enlightenment, emphasize that science is "interesting" and "exciting".

Most evaluations of science were positive. Some critical remarks, based on a utilitarian concept of science held by the respondents, pointed to "useless" research (e.g. marine biology) and the high costs of research in view of tight public budgets. Other critical remarks pointed to the harmful influence of industry and politics on research (reference 5) for an analysis of the pattern of interpreting undesirable developments and events of science in the public as being caused by undue external economic and political pressures).

Asked about their perception of problems in the relationship of science and society, hardly anybody did come up with examples. One engineer mentioned hostility towards technology of part of the population. A few comments were made about the distance between science and everyday life; but there were also a few interviewees mentioning the strong and increasing interrelation. Controversies resulting from scientific and technological developments –nuclear power, food biotechnology, chemistry– were hardly mentioned. That is probably because the exhibition did hardly include such controversial fields of science and technology; so the visitors were not primed to think about such controversial fields. Furthermore, most visitors had positive attitudes towards science and technology (see results of standardized visitors' survey below).

Perceived impact on the visitors' image of science and its relationship with their everyday life

The visitors interviewed generally said that the visit had not changed their perception of science; only few mentioned that the visit had motivated them to look for further information about science. Several, but not all, said that it is likely that they will talk with others about the visit. Although some visitors explicitly said that they could not see the relationship to their personal life, other visitors made connections between what they saw during the visit and their own life. Three examples from several:

- Knowledge about the human body in the exhibition section "humans"
- Physical effects that one can observe in daily life (light dispersion, water waves, magnetism)
- The special exhibition reminded a visitor of the transience of life (her mother just died) and motivated her to reflect on herself.

Several said that they had had a chance to experience "hands on" what they had learned in school only theoretically (e.g. optical experiments, earthquake simulation).

Most interviewees said that they had visited science centres before. They were asked about consequences of the previous visit for themselves. Most had positive memories of their previous visits that they wanted to repeat with their present visit. Several said that they had talked about the previous visit with others; an engineer mentioned the possibility that the visit more than 20 years ago (at a museum of technology) might have played a role in his selection of the subject of his university studies. In general, there is little evidence that a single visit to a science centre serves as a biographical key experience or has a major impact on the visitors.

There is no indication from the interviewee's answers that the present visit was generally evaluated differently –i.e. more positively or more negatively– than their previous visit(s).

Standardized survey

Composition of visitor sample

277 visitors completed the questionnaire during the two days of the survey. Due to the timing of the survey (school holidays) a major category of visitors –school classes with teachers– was missing, but the pupils would not have been included from the survey anyway (because of the age limit for the survey). Visitors below the age of 16 years were not recruited for the survey; some parents forwarded the questionnaire to their children below that age, though. According to the age distribution of the visitors (Figure 1) most surveyed adult visitors belong to the "parent" age group (32-55 years). Actually, the respondents were most often accompanied by family members, i.e. their children and spouses or partners (Figure 2). The most typical situation for a visit thus is that a mixed group of parents and children/adolescents visits the centre; a much smaller fraction consists of grandparents with their grandchildren. It is noticeable from the age distribution that age groups of adults typically not having school children of an age in which the visit would be attractive to them are less represented in the sample (i.e. young adults up to 31 years, and adults older than 55 years). This age distribution suggests that having children (or grandchildren) is strongly related to the decision of visiting the centre. For most visitors the visit to the centre is an infrequent event; less than 15% have already visited the centre in the past 12 months (Figure 2).

The higher proportion of female compared to male visitors seems surprising as science and technology are often seen as "male" domains. Partly, this result may be due to a somewhat greater reluctance of male visitors to

complete the questionnaire. But the impression from observing the visitors in the centre actually is that female adults, adolescents and children are indeed as frequent among the visitors as their male counterparts.

The educational level and professional status of the adult visitors (Figure 1) is far above the average of the national population. More than 40% of the visitors have a degree from a Higher Education Institution (university or university of applied science) compared to only 13% of the national population in 2011.

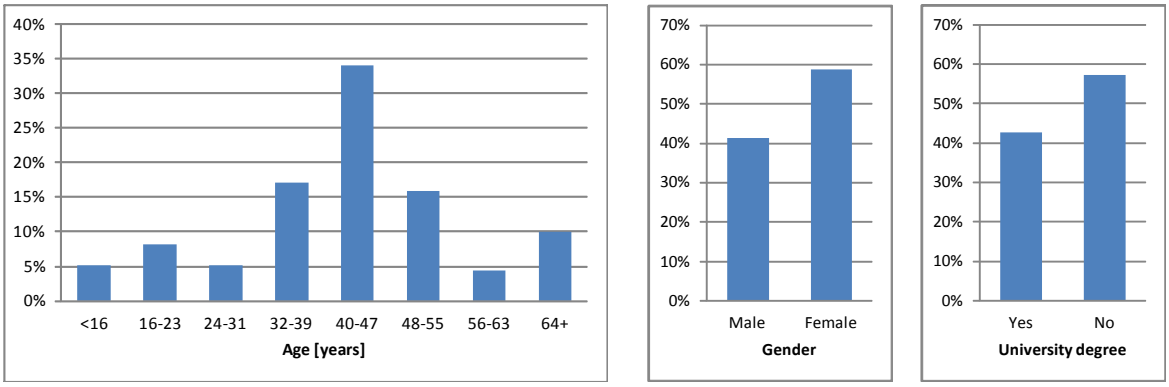

Figure 1. Composition of visitor sample by age, gender and academic training.

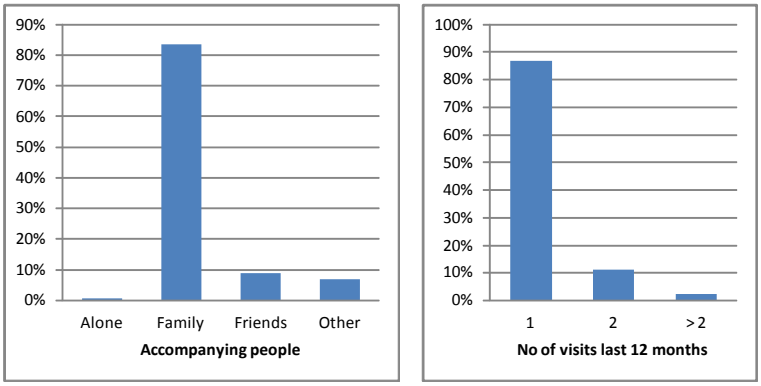

Figure 2. Social context and frequency of visits.

Visitors' beliefs and attitudes regarding science and scientists

Seven statements regarding their beliefs about and attitudes towards science and scientists were presented to the survey participants. They were asked to indicate their disagreement or agreement on a 5-step rating scale ranging from -2 ("completely disagree") to +2 ("completely agree").

The first statement shows that the respondents on average expect clear benefits from science (Figure 3). The distribution of answers by scale values shows that only 2% of the respondents rejected that statement and only 12% were undecided. That means 86% of the visitors surveyed have a clear positive attitude towards science, only 2% possess a negative attitude. Even stronger agreement exists with the statement that it is important to have knowledge

about science and technology (Figure 3). Only 2% rejected that statement and only 5% were undecided. 93% thus think that knowledge about science and technology is important to them. Opinions on the third item about reliance on science vs. faith are mixed between those agreeing and those disagreeing (Figure 3). 42% agree to that statement critical of science compared to 34% disagreeing. However, the question assumes a framing science vs. faith that is not really widespread in the (rather secular) local society. Issues in which religion and science disagree in their claims of explaining the world such as, e.g., the controversy between evolution theory and creationism, do not prevail in the country. It is thus unclear to which part(s) of the two combined statement the surveyed visitors actually responded: too much dependency on science, not enough dependency on faith, or to both statements. Most likely, the visitors responded primarily to the first statement on too much dependency on science – but didn't necessarily agree to "faith" as a logical alternative. However, in any case the distribution of responses to the third item indicates a certain degree of reservation against the dominance of science in culture and everyday life.

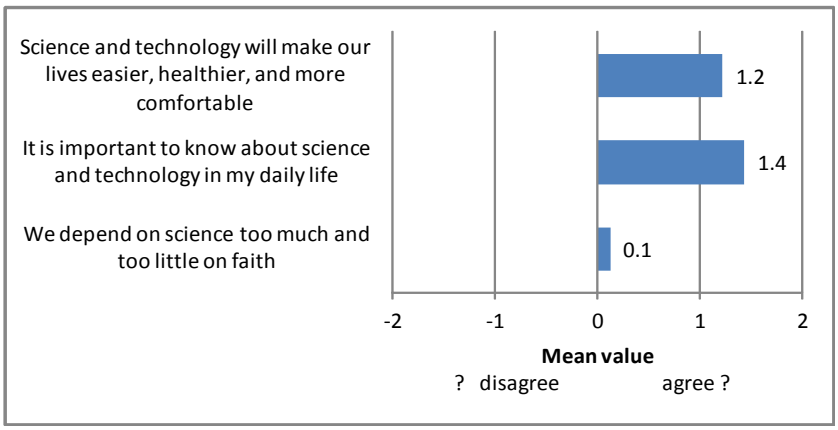

Figure 3. Visitors' attitudes towards science.

The first three items regarding beliefs about scientists and normative expectations about how they should work show an interesting pattern regarding public science communication (Figure 4). Visitors perceive disagreements between scientists to be "normal" and expect that scientists should check findings within science before announcing them (publicly). They do not strongly agree with the demand that scientists should listen more to what ordinary people think. This pattern of expectations corresponds to the popularization model of public communication preferred by scientists: creation, validation of knowledge, and resolving disagreements within science in a first step, then public communication of validated knowledge in the second step. But this implicit model of the surveyed visitors seems somewhat at odds with recent models of the science-society relationship as expressed, for example, in the Public Engagement with Science and Technology (PEST) movement (reference 8). These newer models –if taken seriously– imply permeability of the science-

public border and inclusion of non-scientists in knowledge creation and science governance.

The missing clear disagreement with forth statement on the perceived susceptibility of scientists to expectations of their funders (Figure 4) even points to the perception of adverse consequences of a lack of scientific autonomy and a too close relationship between science and its social environment. Science as institution enjoys very high trust by the national population compared with, for example, institutions of the political and economic sphere. This trust is specifically based on the perception that science *per se* is devoted to the common good (reference 7). If negative developments take place within science, they are often ascribed to external influences, in particular to the corrupting influences of politics and economy. As long as there are no indications that disagreements between scientists and uncertainties in scientific knowledge are the result of external orientations of scientists or resulting from external pressures, they are not leading to a negative evaluation of science but are rather seen as a normal phase in knowledge creation (reference 5).

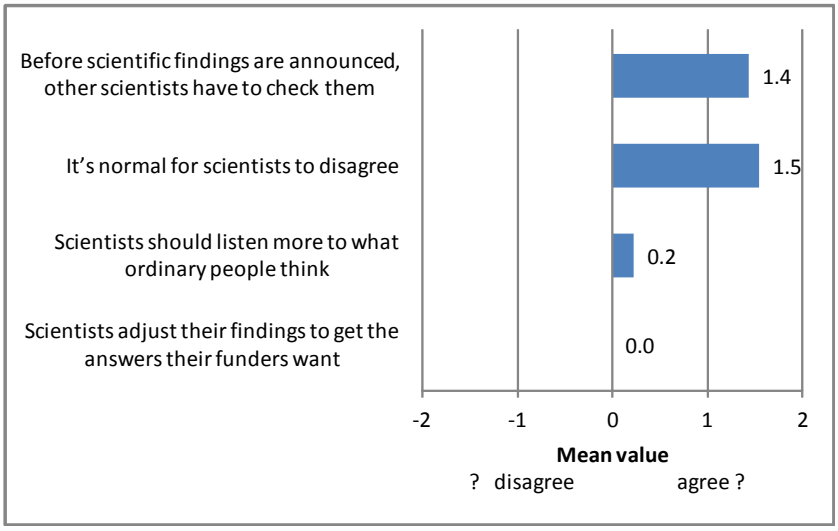

Figure 4. Visitors' beliefs about scientists and expectations of scientists.

Evaluation of visit

The standardized survey included two questions asking the visitors to rate how interesting they found the visit compared with a visit to an art gallery and compared with their experience on science teaching in school. Similar to the results from the semi-structured interviews, more than two thirds of the respondents rated their visit to the science centre very positively and considered it "a lot more interesting" than a visit to an art gallery or their science learning in school (Figure 5). There were hardly any responses indicating that the visit had been boring to the visitors.

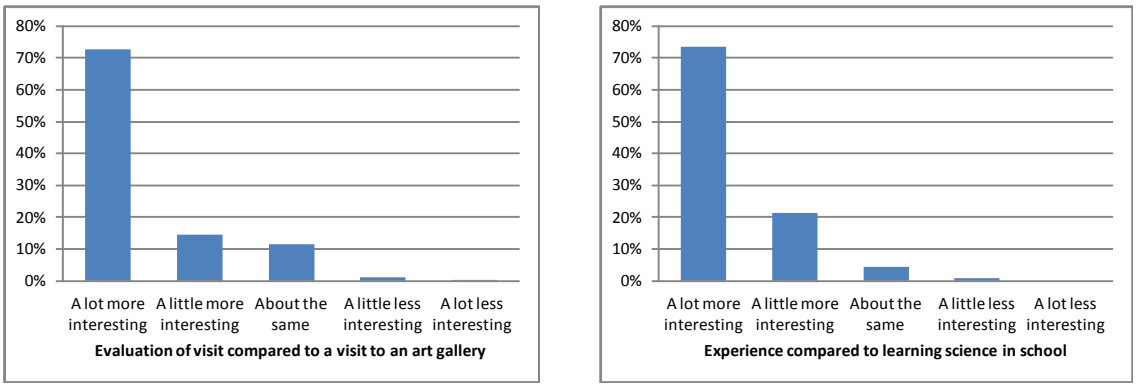

Figure 5. Evaluation of visit to science centre.

Impact of visit to science centre on promoting scientific culture

The measurement of impacts of the visit on the promotion of scientific culture depends on self-assessment of individual visitors, i.e. it is conceptually limited to individual-level effects and methodologically restricted in relying on self-reported "perceived impacts". One may very well assume that on one hand certain effects are over-estimated by this methodology (e.g., reported intention to look for further information), but that on the other hand more subtle effects such as agenda setting, knowledge acquisition or reinforcing and modifying cognitive associations with science or certain scientific findings may be underestimated as they are not always conscious (Friedman, 2008).

The questionnaire included several questions about perceived impacts of the present visit. It also included such questions specifically for visitors who had visited the science centre before in the past 12 months (n=36) about recalled effects of that previous visit.

One of the likely effects of the visit is that the experiences made will contribute to the *ability and likelihood of the visitors to talk within the family and with relatives, friends or colleagues about science*, about their experiences during the visit in the first place, but also –more important for scientific culture– about scientific knowledge and its relationship to society and their personal life in other contexts. More than 60% of the visitors had the impression that the visit had made them feel more confident about discussing scientific issues with other people (Figure 6). Asked about a previous visit, about two thirds of the respondents said that they had talked with family members, friends or colleagues about the topics shown in the exhibition (Figure 8). With some caution because of the methodological issues mentioned above, there is reason to believe that visits to the centre increase the likelihood of references to science in personal communication.

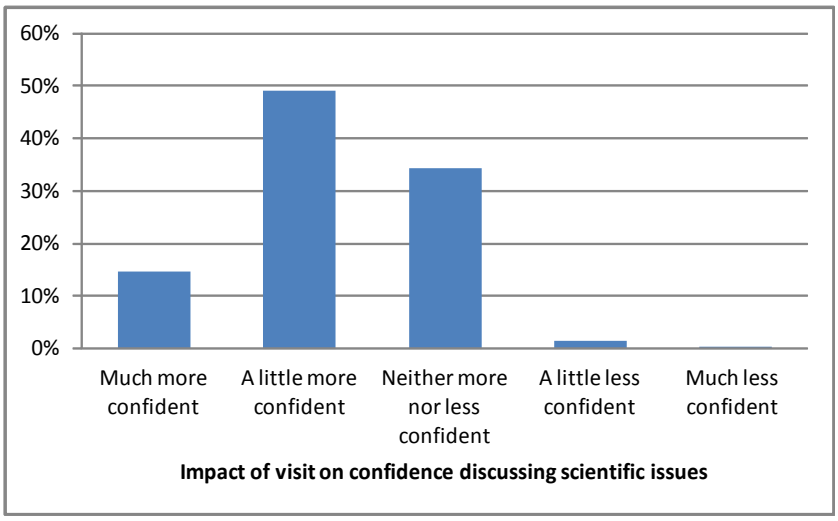

Figure 6. Impact on confidence of discussing scientific issues.

Another likely effect is on the *mental "availability" of scientific perspectives/interpretations* in making sense of (private and public) events and challenges. According to the "tool-box model" described by Swidler in 1986 (reference 9), a culture provides a set of "tools" to guide opinion-forming and decision-making. Visiting a science centre may increase the likelihood that science-related "tools" are used, making science more salient and the culture thus more "scientific". Having ideas of how science is related to one's own life during the visit (Figure 7) or being reminded at the visit when reading newspapers or watching TV (Figure 8) may be indicators of the use of science in making sense of events or perceptions. Almost 30% of the visitors agreed that ideas of how the content of the exhibition is related to them personally crossed their minds during the visit and almost 40% of the repeated visitors agreed retrospectively that when consuming mass media, they had recalled something from the visit. These answers indicate that at least part of the visitors use information or motivation gained from the science centre visit as a resource for sense-making in their daily life.

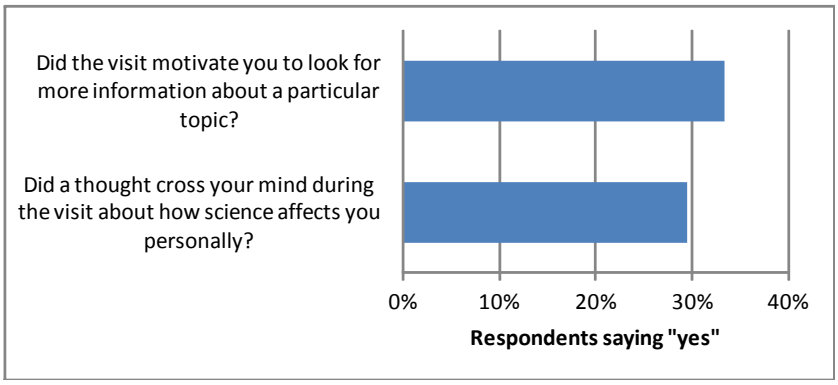

Figure 7. Effects of visit on further information demand and perception of personal relevance of science.

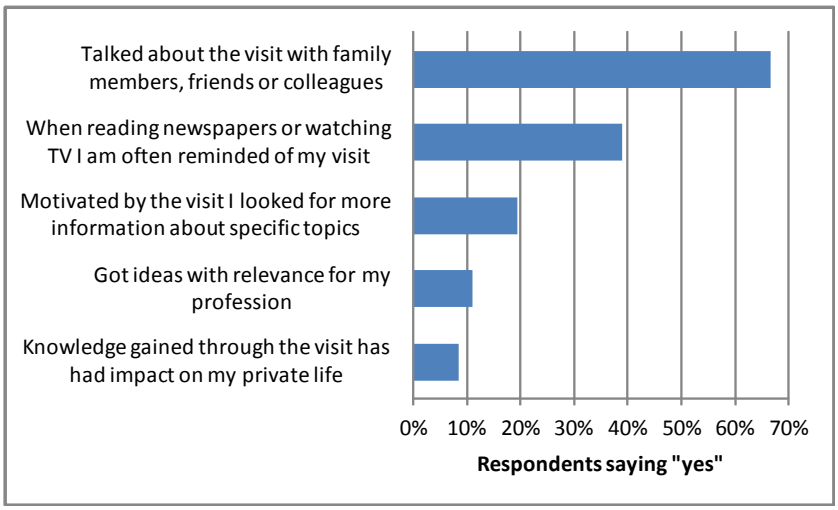

Figure 8. Effects of previous visits recalled by visitors (n=36).

Finally, a visit to a science centre may *stimulate informal science learning about science* by inducing information demand. Certainly, the exhibits to raise interest in certain subjects but hardly can satisfy this interest completely. Because of the limited duration of visits, the design of exhibits in a way that they can be experienced *en passant* and within short time, and the distractions from accompanying persons and other visitors as well as the noise level, there will often be an imbalance between raising interest and satisfying it. About a third of the respondents said that they felt motivated to look for more information about a particular subject (Figure 7) and almost 20% of the repeated visitors confirmed that they had actually looked for further information as a consequence of their previous visit to the science centre (Figure 8).

Knowledge of the term "city of scientific culture"

About 28% of the visitors surveyed confirmed that they know (i.e. "have heard") the term "city of scientific culture". Asked about the meaning of that label, few were able to explain that term, however. Most of those offering an explanation assumed that this term was used for cities with especially many or prominent scientific institutions. Only 8 of 277 respondents gave an explanation that could roughly be interpreted as being congruent with the meaning assigned to this term in the PLACES project, as a city who tries to relate science to its civic environment and imbed it in the city's culture. However, in the country, the term “city of science” is actually used by different cities in different meanings: some use it to denote themselves as a "science city", i.e. a city with several important science institutions, and some cities are assigned the label to label them as "city of scientific culture", i.e. a city that makes particular efforts to connect science with the local/regional community (reference 6). It is thus not surprising that due to the different uses of the term in the country its meaning is ambiguous in the respondents' perception. Asked whether they knew a "city of scientific culture", 26 respondents (roughly 10%) mentioned one or more cities. Of the 55 cities mentioned in total, 18 times the city was mentioned which had actually 2005

received the title in the yearly competition of the city of science of the year, a competition organized by the national institution "Science in Dialogue". Other cities recalled by the respondents as "science cities" were winners of that competition in other years 2006-2012. While lacking a broad impact on the population of science centre visitors, the answers show at least some impact of that national initiative on the respective cities' public image.

Conclusions

Before discussing the relevance of science centres for scientific culture, based on the evidence from this case study, it is necessary to adjust expectations regarding effects of the visits to a moderate level. Most visitors of the science centre come to have a nice day together with their families or friends; their main interest is to entertain themselves and their kids in a sophisticated way. Few come with the explicit expectation to "learn" something specific or to get a new perspective on science. The generally very positive evaluation of the visits shows that the visitors exactly get what they are looking for. Furthermore, the visitors tend to have a higher than average socioeconomic status and a positive attitude towards science. As it has been observed in an analysis of audiences of two space-related exhibitions in the United Kingdom (reference 2), this pattern of self-selection of visitors of science exhibitions implies a low potential for attitude change or increase in interest in science, and –from a persuasion point of view– might even be considered as "preaching to the converted".

However, the analysis of the science centre visitors confirmed their conclusion that –because visitors usually come in groups– family members or friends are motivated to join such visits by those group members who have more interest in science. They are thus exposed to science even if they would not have chosen such an activity by themselves. If one looks at the relationship between generations, this motivating effect works in both directions: parents with interest in science visit the museum because they want to stimulate the same interest in their children; but parents with less interest in science also choose to visit the museum if they know or anticipate that their children would enjoy it. The same group-based motivation mechanism implies that the science centre is not a male-dominated space. If defined as a joint family activity, male and female family members alike are going to enter it.

"Science" and "fun" become cognitively associated during the visit. Furthermore, due to the design of the exhibition science appears cognitively very accessible. This may counter experiences from science teaching in schools which almost all visitors considered much less interesting than the visit. One may expect that visits to science centres help lower barriers to choose a science & technology subject for prospective students. However, as one interview partner rightly observed, the cognitive association between science and fun, and the "easy access to science" approach cultivated in science centres may be misleading the visitors about the character of science and masking the fact that studying a science subject is very demanding. But as the science centre experience for high school students is only a tiny part of their

learning experience with science, it is not very probable that such visits will trick pupils into careers they are not going to master.

According to both, the semi-structured and standardized interviews, strong effects on the perception and appreciation of science by the visitors cannot be expected. However, as shown in more detail above, there is some evidence that the visit increases the following:

- Likelihood of talking about science in everyday life
- Mental "availability" of scientific perspectives/interpretations in making sense of events and perceptions
- Informal science learning by inducing information demand

Science centres contribute to shaping the symbolic environment by encouraging references to science and incrementally add to influences from other sources (such as science coverage in the mass media or science fairs) thus promoting the proliferation of a scientific culture. However, besides increasing a perception of societal significance of science, strengthening the belief of ubiquity of science in culture and everyday life may paradoxically also induce a critical belief about the dominance of science compared to other sources of sense-making, leading to uneasiness and a more reserved attitude towards science. One may refer to the concept of a "colonization of the life-world" (reference 4) to understand the reservations against science underlying the ambivalent responses to the statement that "we depend on science too much and too little on faith" (Figure 3). There is no straight line between representation of science in everyday life and positive attitudes towards science.

Recommendations

There are different ways to present science to the public through exhibitions: "museums of science and technology", "museums of natural history, anthropology and medicine", "planetariums", and "science centres" (reference 6). The centre of this case study is of the last mentioned type –a science centre strongly trying to show surprising effects and enable "hands on" activities by the visitors. The display of original scientific artefacts behind glass –the focus of historically oriented science museums– is not the aim of the science centre. Each of these types of science exhibitions has its own audience or –if one looks at it from a marketing point of view– "target group". Science museums are economical enterprises and have to meet the demands of their customers. However, the investors may have goals regarding the "Public Understanding of Science" beyond making profit, but recommendations to optimize the impact on scientific culture have to keep in mind the economical constraints.

Diversity of exhibits and ways to enjoy

Based on the results of the case study the offer the science centre makes is attractive to its intended customers. The first recommendation regarding the character of the centre and the type of displays is thus more an explicit confirmation of the general strategy employed already than a suggestion to change it. The core of the offer by science centres like that one to their visitors is "sophisticated entertainment". As the visitor groups are usually mixed in terms of age (adults vs. children), gender, and level of interest in science, this offer has to be diverse in term of topics (e.g. life sciences vs. physics and engineering), concepts of science (utility vs. knowledge/enlightenment), visiting mode (active vs. receptive) and in-depth level (sensation-seeking vs. understanding natural laws and principles). The makers of the exhibition have to find the right balance between different kinds of exhibits; furthermore they should aim at providing different ways of using them.

Supporting visitors as ambassadors

Visitors typically come in one of two group settings: as part of a school class' during an excursion, and as part of a family or group of friends. During the interviews several references were made to the respective other setting. Interviewees mentioned that their visit as family has been stimulated by the visit of one of the children with his/her school class; other interviewees suggested to their children that they should ask their teachers to make their next school excursion to the science centre. Maybe science centres could use this cross-reference to their advantage by providing information about school visits to

children and parents coming as family (on weekends and in holidays) and providing a leaflet for the parents emphasizing the value of the visit as a family activity to children coming in the context of a school excursion (during the normal school weeks). It might also be useful to encourage visitors to register on site with their email address for an online newsletter reminding them of the visit and informing them about news and special events regarding the science centre, or to become "friend" of the centre on Facebook.

Increasing the number of repeated visitors

At the end of the visit, visitors are generally overwhelmed. They have the impression that they have not seen everything, and that they have not "digested" everything they have seen. Many feel the need to come back. Maybe science centres can build on that feeling by making appropriate offers at the end of the visit –such as a reduced entrance fee for a follow-up visit within a certain time period or the offer to give credit for the already purchased one-time ticket when buying a season ticket.

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6. Here the author refers to an article about a national overview on the scientific culture in the country of this case study. The name of this article has been suppressed in order to maintain the anonymity of this case report. If you need more information or wish to know more about it, please send a message to occ@upf.edu.

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