Different Images of Science at Nordic Science Centres

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Abstract

Science centres aim to present science in ways that will attract visitors and enhance public interest in, and knowledge of, science. But what images and different aspects of science are visitors confronted with at Nordic science centres? This study aims to explore the different aspects of science that are displayed and the ways in which these aspects constitute different images of science. In this study, staff members who work with the planning and creation of new exhibitions were asked to answer a web-based questionnaire, identifying the extent to which different aspects of science were displayed in their latest exhibition. They were also asked to voice their opinions on what, and to what extent, they would like to display different aspects in future exhibitions. This study shows that exhibitions today in particular choose to display the wonders of science, presenting science in a product-oriented and unproblematic way. The study also reveals a great discrepancy between what staff members display at their latest exhibitions and what they want to display in future exhibitions. They express a will to emphasise aspects of science on the basis of a societal and cultural perspective. This means that controversial

issues, values in society, non-western science and scientific processes constitute important components for future exhibitions.

Introduction

Science centres worldwide aim to present science in ways that will attract visitors as well as enhance the interest in, and knowledge of, science. A number of research studies have been carried out in order to investigate the outcome of these institutions. A majority of these studies are related to learning outcomes and attitudes toward science (eg Heard, Divall and Johnson, 2000; Nyhof-Young, 1996) or visitors' perceptions and interactions with exhibitions (eg Pedretti, Macdonald and Gitari, 2001; Brook and Solomon, 1998). However these studies do not discuss the foundations and assumptions on which staff members at science centres base new exhibitions and thereby conveying messages of what science is. An important question is what images and different aspects of science do a visitor actually meet at a science centre? Is science presented as a dynamic, engaging, open and multi-faceted subject area or are ready-made, product-focused and stereotyped images shown? These questions formulate two extremes to how science can be presented and are not really

possible to answer in any unambiguous way. Still, they raise some interesting and important questions for discussion. What images of science are possible to display at science centres and what constitutes these images? What aspects of science are chosen by the staff when exhibitions are constructed?

This article focuses on the aspects of science staff members believe they display in exhibitions and also the aspects they would like to display in the future. The aspects that the respondents considered derive from the ongoing debate about the nature of science. These aspects are presented in detail in the following sections. The article is the first part of a larger project that aims to explore the presumptions staff members have on communicating science through exhibitions. The study is based on a questionnaire of all staff members responsible for constructing exhibitions at 30 Nordic science centres. There is a lack of studies dealing with these issues, in the Nordic countries as well as internationally. This has made it necessary to get an overview of and a starting point to further studies. Future studies will be based on further triangulation of methods using interviews and participatory observation at Nordic science centers.

The wonders of science

Lately, museums and science centres have been criticized and questioned when science has been presented in a too narrow-minded way (Pedretti, 2002; Menved and Oatley, 2000; Frøyland and Henriksen, 2003). Pedretti (2002) contends that many museums and science centres just show ”the wonders of science”, i.e. an unproblematic, product-focused way that shows the ”good things” we humans have accomplished through science. She argues that there is a need for change; a need for diverting attention away from the *wonders of science* to exhibitions related to contemporary and sometimes even controversial science. Such exhibitions enhance learning through an increased attention on context - not only the context in which science operates, but also the visitors' contexts. By promoting a public debate about science, and not just presenting scientific facts, it entails understanding the nature, processes and achievements of science. It also entails critiquing the institution and practice of science (Pedretti 2002). Other scholars argue for integrating experiences from museums or science exhibitions into the visitors' every-day life, linked to different social and cultural activities. This places scientific principles in more familiar contexts and could provide a starting point for reflecting on

scientific issues that have an impact on decisions made in everyday practice (Menved and Oatley, 2000; Jenkins, 2000). Frøyland and Henriksen (2003) contend that museums can and should to a greater extent turn towards society in order to contribute to an increased scientific literacy. By having exhibits about controversial themes and by using new methods to describe the themes, museums can reach a broader audience and thereby take a more active role in society. When young people are confronted with what is already known in science, without learning how we have come to know it, the understanding of social, cognitive and epistemic dynamics is eliminated.

There is also a need to focus on the constructions and evaluations of knowledge claims, on the places where concepts and processes are shaped and take on meaning (Duschl, 2000). This does not only involve knowledge in science but also knowledge about science, an understanding of the nature and status of science. Driver et al. (1996) describe this as being the way in which the body of public knowledge called science has been established and is added to, what our grounds are for considering it reliable knowledge and how the agreement that characterizes much of science is maintained. Also Rennie and Stocklmayer (2003) contend that

science museums, to a greater extent, must try to reach people that never visit museums and suggest two aspects intended to increase public engagement. They suggest that science centres need to seek and involve the public's views through debate and consensus and also initiate outreach activities. In another study, Rennie and Williams (2002) found that staff at an Australian science centre had different understandings of what aims the science centre should have. Two thirds believed that one important aim was to influence the images of science the visitors had before their visit. But almost half of the staff thought that the main aim was to display science and science applications. Rennie and Williams found that the staff was generally content with the positive exhibition impact on visitors, but some also felt that there was room for improvement when it came to presenting the nature of science and controversial issues.

Images of science

If scientific products and facts are the main aspects of science that one can expect to find in a science exhibition like Pedretti (2002) argues, what is then the unexpected? Ogawa (1998) stresses that science, as it exists in different communities, is interpreted and constructed by its citizens on the

basis of the context and the culture they live in. From the citizens' experiences, science is a constructed image believed to be culture-independent. He contends that there are no culture-free interpretations of science. Different ways of presenting science can always only be interpretations of what science is actually about. What implications does this argument bring to the science center movement and what aspects of science risk to be underrepresented? For example Hodson (1998) talks about *learning about science*, where there is focus on acquiring knowledge and understanding of the processes and sub-processes of scientific inquiries. This involves learning about different strategies and tactics used by scientists, in order to understand different phenomena. He also stresses the importance of understanding the role of evidence in scientific knowledge building. Also Lemke (1997) emphasises the sub-processes and the role of evidence by arguing that learning science is to learn about how we re-make our views about the world. This argumentation is crucial, when scientists in different research communities publish and discuss results and evidence. These discussions lead to a greater acceptance for explanations of a certain phenomenon and eventually also consensus in the actual issue. Sutton (1998) too discusses

the importance of learning about how we reach consensus. He contends that the language used for argumentation has changed gradually over time and is now to a great extent detached from the humans behind science. This leads to losses in educational points of view as it gives a very misleading impression of how new knowledge has been established. To make these issues explicit in science exhibitions one would need to display scientific uncertainties and the humans behind science. There are numerous examples of competitive explanations in history and here it is also easy to see the humans behind the discoveries, e.g. the different theories of natural selection held by Lamarck and Darwin. Likewise, it is not hard to find uncertainties and controversies in contemporary scientific debate that can be emphasised in exhibitions. The humans behind new findings as well as how consensus is reached, are part of the public debate and less seldom discerned in scientific exhibitions.

Another area for discussion is the importance of science in society and also the view of science as an objective search for truth that is undergoing change. Driver et al. (1996) describe *science as a social enterprise*, which involves the understanding of science as an institution, embedded and controlled by society. Sjøberg (1998) also emphasises science as being

part of society when discussing the relationship between science and for example technology, ethics or politics. Decisions concerning scientific or technological development are taken on the basis of particular interests in society that are of benefit to some and perhaps at the expense of others. One part of a scientific exhibition could display these tensions of different political, economical or ethical interest groups in society; for example, the tensions between the tobacco industry and health organizations or between the car industry and different environmental groups. Another possibility is to make explicit the decisions and positions that provide the foundation for how research funding is dispersed.

There are also several examples in *science history* where values and beliefs in society that have affected scientific thoughts can also be displayed in science exhibitions. For example, religions beliefs played a big role for the acceptance of scientific explanations when Galileo argued in favour of the heliocentric view and was forced to withdraw his findings and apologize to the church. Today there are many communities worldwide that do not accept certain scientific explanations in favour of religious ones. Also, in modern societies sub-cultures have created their own explanations through their shared experiences, values and beliefs

(Aikenhead, 2000). This can be seen for example in US where different religious groups do not accept the theory of evolution as the only explanation or even a valid explanation to understanding the origin of species. All these examples are meant to relate science to other phenomena in society and make explicit that science does not only consist of scientific products, but is also a part of, is affected by, and affects our society.

Different cultures have also affected and still affect the apprehensions of *gender issues*. Several research reports show large gender differences concerning, for example, the interests in different science areas, an unequal division of men and women, where more men enter into scientific and technical educations (TIMSS 2003, OECD 2003, Sjøberg, 2000).

Through language, another consideration of the gender issue and science becomes clear. Hughes (2004) argues that gendered dichotomous thinking, which is an inheritance from the 17th and 18th centuries, is still present in associations where physics is seen as masculine, hard, objective, abstract rationality, whereas social and human sciences connote a feminine, more subjective and softer approach. The abstraction and objectivity of pure science is then associated with masculinity while the

contextualized approach relates to femininity. Also Keller (1992) discusses gender issues on the basis of language. She points to this perspective when illustrating the way scientific constructs, related to the female egg, are described with words like 'passive', 'is transported', 'drifts' and 'is penetrated'. Words like 'active', 'self-propelled' and 'penetrates' were related to the male sperm. Keller contends that by investigating the symbolic aspects of masculinity in science, gendering of science as a social construct rather than being biologically determined is revealed. Exhibitions can create an awareness of gender as a social construct. Also, hierarchies related to gender issues in science can be emphasised, for example in scientific concepts related to language.

A wider societal perspective of science can also incorporate *science from non-western cultures*. As mentioned before, Ogawa (1998) and Riess (2004) argue that there exists no single, universal, a-cultural science, but instead all sorts of sciences are ethno-sciences. This is based on the fact that interpretations of our world are made by scientists, through senses affected by themselves as persons and their cultures. Even Aikenhead (2000) promotes the view of science being affected by the existing culture and argues that western science is one of many sub-

cultures of Euro-American society. Cobern and Loving (2004) discuss the importance of indigenous knowledge, both historical and present. They argue that it is of great value, since it broadens what is taught as science. In science exhibitions, science from non-western cultures could illustrate ways in which science is affected by the culture it operates in.

In this study, aspects of science refer to the different foci an exhibition can have. As mentioned before, an exhibition could for example focus on the wonders of science, learning about science, science as a social enterprise, science history, gender issues or science from non-western cultures. It is of course impossible to display everything within a subject area at an exhibition. Each exhibition is a result of conscious or unconscious choices, made by staff members concerning different aspects of science. The aspects of science will be used to analyse different and possible connotations that exhibitions at science centres choose to express. In this way comprehensive *images of science* can be described. These images thus depend on how exhibitions are constituted.

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The study

In the previous section the authors discuss how science generally can be manifested by relating science to historical, social and cultural perspectives. However their arguments are not usually based on empirical studies, but instead elucidate the ongoing debate about these issues. A problem in the science center enterprise is the lack of studies that investigate how science can be manifested and displayed and thereby convey messages to the visitors about what science is. This means that we

today have insufficient knowledge about what aspects of science that are presented in exhibitions. Therefore this study aims to explore different aspects of science that are displayed at Nordic science centres and how these aspects constitute different images of science. That is, to study staff members' own understanding of the extent to which they display and would like to display, different aspects of science. The research questions in this study are:

- What aspects of science do staff members display in their present exhibitions?
- What aspects of science do staff members express they would like to display in future exhibitions?
- In what ways do these aspects constitute different images of science?

The questionnaire and methodological considerations

The reason for choosing a questionnaire in this study was to get a general view of the different aspects of science that were displayed, but also a will to attend to the lack of empirical studies in the area. The questionnaire aimed at collecting data from staff members working at

different science centres, spread over a large geographical area, in the Nordic countries, during a relatively short period of time. It also made possible statistical analysis of the data. To be able to answer the research questions, the questionnaire was developed in order to ascertain to what extent the staff members apprehended that different aspects of science were displayed in present exhibitions. They were also asked to consider to what extent they would like to display the same aspects in a future exhibition. The aspects in the questionnaire have their origin in the previous discussion about what science can be. This means that aspects like 'science in society', 'values in society' and 'controversial issues' derive from the discussion about *science as a social enterprise*, where science is seen to be influenced by for example economy, ethics and politics. The aspect 'how modern science is generated' derives from *learning about science*. 'Gender issues', 'science from other cultures than our own' and 'science in a historical perspective' were discussed separately. Finally 'scientific facts' 'science in a technical perspective' and 'experiences of everyday phenomena' have its origin from the critique of Pedretti (2002) arguing that science centers only displayed "the wonders of science".

Since the respondents only were asked to consider a limited number of aspects there is an obvious risk that the questionnaire only enlightens a part of the problem.The chosen aspects are of course not the only ones that can be displayed and it is likely that other aspects of science would enhance an image or even constitute other images of science. Even though the result may be affected by these circumstances, the goal has above all been to cover a broad view of the ongoing debate. This study is therefore just the first part of a larger project that aims to explore what presumptions staff members at science centres have when they communicate science through exhibition displays. That is to make explicit the presumptions which the staff members take for granted as members of the science centre culture. In this way, this study also aims at providing indications for further research. Thus is this survey a part of a method triangulation where ethnographical methods such as participating observations and interviews will be included.

The selection of respondents includes directors of the science centres, and staff members working at the centres with developing and creating new exhibitions. A web-based questionnaire was sent to 88 persons and more than 75 percent (66 persons) answered. In all, staff members from

30 science centres participated in the study and. This means that all Nordic science centres, members of the NSCF (Nordic Science Center Association) have participated in the study. The respondents were asked to answer questions concerned with the extent to which they considered that the latest exhibition at their science centre displayed different aspects of science. They answered every question on a five grade scale from "*to a very low extent*", represented by figure 1, to "*to a very high extent*", represented by figure 5. The questions were focussed on the extent to which the staff members considered the latest exhibition to display:

- scientific facts;
- science in society;
- experiences of everyday phenomena;
- gender issues;
- science from other cultures than our own;
- controversial issues;
- how modern science is generated;
- values in society;
- science in a historical perspective;

- science in a technical perspective

The staff members also considered the same aspects of science, relating these to what they preferred to display in future exhibitions. The purpose was to make the staff members' intentions explicit and analyze possible distinctions between the desires to present different aspects in future exhibitions to what was actually being displayed.

Analysis

Through the statistical analysis both the individual respondents' apprehensions and the mean values of the aspects became evident. This was however not sufficient, since it could only account for each aspect separately. The question was if these aspects, on the basis of the data, could be combined in order to constitute different images of science. In the theoretical background some aspects seemed to be more frequently occurring than others, when presenting science (e.g. scientific facts, science in a technical perspective and experiences from everyday phenomena). From the first analysis, the mean values also made explicit that some clusters of aspects had higher values than others. This pointed

to the fact that some items in the data were interrelated. This interrelation can be visualized through principal component analysis, which reveals latent relationships between items. In conducting principal component analysis, the orthogonal rotation Varimax was chosen. This brought out groups of items (aspects), which indicated that the exhibitions displayed certain aspects of science in favour of others. In such a group, the aspects constitute, what in this study are described as images of science. To measure the reliability of the questionnaire, i.e. to find out if the aspects were really interrelated, the value of Cronbach's alpha was calculated. A value above 0.70 is an acceptable value, but a value just below this can also be realistic due to the diversity of what is being measured (Field, 2005).

Results

Images of science in present exhibitions

The first analysis showed big differences in the extent to which aspects of science are displayed. Table 1 illustrates that the considerations of what was displayed were divided mainly into two extreme groups of aspects, one with high, and one with low mean values. Only one aspect, 'science

in a historical perspective' (3.22), was found in-between these extremes. The highest mean value was related to 'experiences from everyday phenomena' (4.09). When analyzing how the individual respondents answered, the dispersion related to this aspect was low. Other aspects with high mean values, were 'scientific facts' (3.94), 'science in society' (3.89) and 'science in a technical perspective' (3.69). For these aspects the dispersion of answers was slightly higher.

The low mean value group contained five aspects. The lowest mean value was related to 'science from other cultures' (2.09). Nearly all the respondents experienced that their exhibitions displayed this aspect to a very low extent. The other aspects in this group were 'gender issues' (2.77), 'values in society' (2.75), 'controversial issues' (2.60) and 'how modern science is generated' (2.59). Among these aspects the dispersions of answers was large, with few answers in the middle of the scale.

Place table 1

The analysis pointed to two main clusters of aspects that represent latent factors. This implies that a number of hidden relationships were made evident. These relationships can mediate different images of science that the exhibitions convey (see Table 2).

The first factor, *the usefulness of science,* contains the aspects 'science in society', 'science in a technical perspective', 'how modern science is generated' and 'scientific facts'. The aspect 'science in society' had the highest correlation within this factor. A probable connotation, in line with 'science in a technical perspective', is that this kind of exhibition mediates the usefulness of technical achievements in our society. The aspect 'scientific facts' emphasises science as a foundation for scientific products. By describing science mainly through the explanation of concepts and theories there is a risk that science is displayed according to the wonders of science (Pedretti, 2002). This means that science risks to be portrayed in single-dimension and authoritarian ways, i.e. all questions have one correct answer.

The aspect of how modern science is generated emphasises scientific processes. But when related to the other three aspects within this factor, the usefulness of scientific products is emphasised through scientific processes. The aspects reinforce and increase the image of science as being concerned with the usefulness of scientific products in our society. On the basis of this analysis, an explicit image of science appears, *the usefulness of science*. Mainly this image conveys the usefulness we, as

individuals or as a society, can gain from science. It can also convey all the good that can be achieved through science, without discussing problems related to these technical and scientific achievements. Three of these aspects had high mean values and a probable interpretation is therefore that this is a common image shown at Nordic science centres.

Place Table 2

The second factor, *science and culture*, (see Table 2), consists of the aspects 'gender issue', 'science from other cultures' and 'science in a historical perspective'. The aspect 'gender issues', has the highest correlations within this factor. Gender issues can be related both to existing norms and values in society as well as in the scientific community. By relating to gender issues, the implication is that science consists of more than just concepts, figures, theories and scientific applications. In this way science can be related to the existing inequity between men and women. It can also make explicit the women and men behind scientific findings. Hughues (2004) argues that there is a risk in describing science without this perspective is that science is displayed in an inhuman way, where science seems to be unaffected by interpersonal relationships and conflicts.

By displaying the aspect of science from other cultures, it is possible to convey the belief that science is of wider concern than just being aimed at an elite group of white, western men (Aikenhead, 2000). It can also in this way make explicit the gap between Western science that operates in rich, developed countries and science in third world countries. Through the historical perspective, science of today can be compared to science in a historical context. This is also elucidated when displaying different understandings of historical phenomena. An exhibition can for example stress the nature of science and how scientific knowledge becomes established through anomalies and scientific disputes (Sutton, 1998). These three aspects together, as illustrated in Table 2, interrelate and create the image *science and culture*. According to the mean values in Table 1, this image is less commonly occurring in exhibitions today. *Science and culture* connotes that science is affected by women and men that live and have lived and thereby makes science an integral part of our culture.

The two images *the usefulness of science* and *science and culture* (see Table 2) describe how the aspects interrelate and constitute different images of science. The figures represent how well correlated each aspect

is to the factor in the analysis; where 1 is the maximum and -1 is the minimum (0 is absolutely no correlation whereas -1 is a directly opposed correlation). In a reliability test *the usefulness of science* gets a Cronbach's alpha of 0.70. *Science and culture* gets a Cronbach's alpha of 0.59 which is an acceptable value (Field, 2005).

Images of science in future exhibitions

The respondents were asked to reconsider the ten aspects of science, relating these to the extent to which they would like to display them in future exhibitions. The intention was to make explicit the respondents' own desires to display different aspects. It also aimed at describing possible differences between how science is displayed today, compared to how the respondents themselves stress certain aspects. The result shows, as illustrated in Table 3, that the mean values for each aspect is higher when compared to the respondents' views related to the extent to which these aspects were displayed in their latest exhibition. A probable explanation is that there is a greater will to present different aspects than perhaps is possible. Despite this, there are big differences between how the respondents actually display the aspects and the extent to which they would like to display them.

Place table 3

In Table 3 it can be seen that the aspect 'experiences of everyday phenomena' has the highest mean value (4.48) related to what the respondents would like to display. It also has a very low dispersion of the answers. Other aspects that have high mean values are 'science in society' (4.29), 'scientific facts' (3.98) and 'science in a technical perspective' (3.98). These were the same aspects the respondents believed their latest exhibitions displayed to a high degree. There is thus both a statement that these aspects are displayed in present exhibitions and a will to display them in future exhibitions. Some aspects have relatively low mean values related to the matter of what is actually presented, but have high mean values when it comes to what the respondents would like to display. In other words, these aspects represent perspectives that the respondents express are not sufficiently evident in present exhibitions. For example, 'gender issues' has a high mean value (3.98) in matters related to future exhibitions, compared to what is actually displayed (2.77). This is also true for how modern science is generated as well as matters having to do with 'controversial issues'. 'Science from other cultures' has the lowest

mean (3.75) and is thereby the aspect the respondents would like to stress least of all in future exhibitions. This aspect has the lowest mean value related both to present and future exhibitions. 'Science in a historical perspective' has the second lowest mean value (3.86) related to future exhibitions. In present exhibitions, this aspect has a relatively higher mean value compared to the other aspects, pointing to the fact that the respondents to a higher extent prefer emphasizing other aspects of science in future exhibitions than the historical perspective.

The principal component analysis was again used to distinguish hidden relationships in the data. Here the results point to the fact that, even when it comes to the respondents' own will to display certain aspects of science in future exhibitions, there exists clusters of aspects. Here, three different clusters became evident, which are illustrated in Table 4.

The first factor, *Science, technology and culture* contains a combination of aspects that are almost the same as the previous image *science and culture*. It consists of the aspects 'science from other cultures than our own', 'gender issues', 'science in a historical perspective' and 'science in a technical perspective'. As mentioned earlier, the image *science and culture* connotes that science is affected by past and present

men and women in our society and is thereby a part of our culture. An interesting difference, related to what the respondents would like to display, is the addition of 'science in a technical perspective'. In *the usefulness of science,* the technical perspective is related to the use humans have of science in our society. When it comes to the image *science, technology and culture*, the technical perspective can take on another meaning, since it is related to other aspects. These aspects can emphasise humans behind science, the influences of society and the fact that science is of wide concern in our world. In this way, the technical perspective can connote that it is part of as well as affected by our culture. *Science, technology and culture* implicates placing science and technology in a human context, related to past and ongoing trends in society, pointing towards the intention of not only displaying technology in terms of figures, facts and the usefulness of technical devices.

From the analysis, two other clusters of aspects also appear and consequently create two images of science. The second factor of concern to what the respondents would like to display is *science debate*. As seen in Table 4 it consists of the aspects 'controversial issues', 'values in society' and 'how modern science is generated'. 'Controversial issues'

have the highest correlation within this factor. This aspect, along with 'values in society', can connote conflicting socio-scientific issues related to contemporary science and scientific research (Driver et al, 1996). This discussion can be further deepened through considering the aspect of 'how modern science is generated', as it accentuates scientific processes (Hodson, 1998). In *the usefulness of science*, this aspect has a product-oriented focus and could display how to develop new products. In *science debate*, scientific processes are emphasised through socio-scientific issues. An exhibition of this kind can connote that science is also about debate, argumentation and the submission of evidence (Lemke, 1997). Questions about what kind of scientific research we need and what the consequences are for humans and our environment can convey the view that science is affected by ongoing discussions in society.

Place table 4

The third factor (see Table 4) is *informative science*. It contains the aspects 'scientific facts' and 'science in society'. The aspect 'scientific facts' has the highest correlation within this factor. This aspect can be

illustrated through figures, explaining concepts and describing measurements, laws and theories. Scientific facts can describe knowledge already proved and considered valid, leaving little room for discussion. 'Scientific fact' is combined in this factor with 'science in society', which can connote the usefulness of science in our society. Here this is done without considering a technical perspective or how modern science is generated, as in *the usefulness of science*. An exhibition based on scientific facts and science in society risks regarding science in a narrow-minded way, where much within science is excluded (Pedretti, 2002; Menved and Oatley, 2000). In a reliability test the values for Cronbach's alpha are 0.72 for *science debate*, 0.74 for *science, technology and culture* and 0.60 for *informative science*.

Discussion

The results of this study point to that two images are mainly presented in exhibitions at Nordic science centres. The image *the usefulness of science* displays science primarily in a product-oriented way through presenting the usefulness of technical achievements in society. As such, this image

confirms the critique from Pedretti (2002) and Frøyland and Henriksen (2003).

However, the results of this study point to a more complex and multi-faceted image. Through statistical analysis, it becomes evident that even scientific processes are made explicit in exhibitions. According to the staff members, the scientific processes become explicit through displaying scientific products and scientific applications in a societal perspective. But Duschl (2000) contends, that if scientific processes are to be understood, they also need to include the constructions and evaluations of knowledge claims and how consensus is reached in the research community. Seen in this perspective, scientific processes, as presented in *the usefulness of science,* risk to be displayed in an insufficient way.

The second image is *science and culture* and expresses science from a gender, historical and non-western perspective. The mean values of the aspects are proportionately low, which also indicate that this image does not occur frequently. Many scholars (eg Hughes, 2004) argue that the aspects in this image are often lost when presenting science, but are at the same time important parts in the need to increase an interest for science and technology. Exhibitions that contain the image *science and culture*

can in this way contribute to questioning this stereotyped perspective of science (Riess, 2004; Ogawa, 1998). This image of science also incorporates science from non-western cultures. The image *science and culture* also makes explicit the humans behind science, creating opportunities to display a more human image of science (Sutton, 1998).

An explicit result in this study is the evident differences in staff members' assumptions of what is actually displayed and what they would like to see presented in future exhibitions. On the whole, all aspects of science acquire higher mean values in future exhibitions. One explanation is the will to display as many aspects of science as possible. But at the same time some aspects diverge and acquire a significantly higher mean value in future exhibitions than others. Some examples of these kinds of aspects are 'science from other cultures', 'how modern science is generated', 'controversial issues' and 'gender issues'.

An important question is why staff members experience some aspects as less explicit as they would wish. What probable explanations can there be for this phenomenon? Are these aspects of science not accepted in the scientific community? To what extent do sponsors affect the content of exhibitions? Is there a fear of being accused of taking positions in

sensitive questions about science? Questions of this kind are outside the frame of this study, but are at the same time crucial to understanding the images of science that are displayed at science centres.

The analysis of what staff members would like to see presented in future exhibitions reveals three main images. The first image *science, technology and culture* accepts technology as an important part of science in a human context, affected by our society and culture. A possible interpretation of this image is the intention of emphasizing gender issues and science from other cultures through a historical and technical perspective. The significance of displaying this image of science is confirmed by Driver et al (1996) and Sjøberg (1998).

The second image in future exhibitions is *science debate*. This image elucidate the importance of displaying socio-scientific issues by stressing the aspects 'controversial issues', 'values in society' and 'how modern science is generated'. This is also confirmed by Rennie and Williams (2002). Several scholars (e.g. Pedretti, 2002; Menved and Oatly, 2000) have called attention to the importance of controversial issues in science. Further, Frøyland and Henriksen (2003) contend that exhibitions about controversial themes can reach a broader audience and thereby contribute

towards playing a more active role in society. There seems to be extensive agreement concerning this issue, where staff members and researchers in science education would like to see more socio-scientific issues related to contemporary and controversial science. An important question is: what prevents science centres from displaying this image of science? Even this question can provide a base for future research in this area.

The third image, *informative science*, contained the two aspects 'scientific facts' and 'science in society'. An exhibition based only on these aspects, risks regarding science in a narrow-minded and unproblematic way, similar to what Pedretti (2002) described by "the wonders of science". In this image much within science is excluded.

This study has pointed to the existence of two main images of science when science is displayed at Nordic science centres. It is above all a narrow-minded and product-oriented image of science that is evident, where scientific processes in many respects are absent. The study also reveals a discrepancy among the staff members' thoughts related to what their latest exhibitions displayed and what they themselves would like to see displayed in future exhibitions. The result has made explicit the existence of different images of science. Images that appear in science

exhibitions depend on what aspects staff members decide to display. However in this study the respondents considered a limited number of aspects, which can have resulted in that some images have not been made explicit. Nor has it been possible to analyze the underlying causes of why these images of science are used. An increased understanding of the implicit presumptions about science and learning about science will require additional studies. Future studies should thus be directed towards finding explanations for the pertinent differences that exist between what is presented today and what staff members themselves find desirable to display in future exhibitions.

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TABLE 1: Mean values for the extent each aspect of science was displayed according to the respondents' assumptions about their latest exhibition.

In what extent do you think the latest exhibition displayed	Mean values, latest exhibition	Std. deviation
Experiences of everyday phenomena	4.09	0.84
Scientific facts	3.94	1.11
Science in society	3.89	0.95
Science in a technical perspective	3.69	1.10
Science in a historical perspective	3.22	1.24
Gender issues	2.77	1.30
Values in society	2.75	1.11
Controversial issues	2.60	1.25
How modern science is generated	2.59	1.15
Science from other cultures	2.09	1.06

TABLE 2: Images of science displayed in present exhibitions

The usefulness of science	Science and culture

Science in society (0.81)	Gender issues (0.79)
Technical perspective (0.77)	Science from other cultures (0.77)
How modern science is generated (0.70)	Historical perspective (0.58)
Scientific facts (0.61)	

TABLE 3: Mean value for the extent to which the respondents would like to display each aspects of science in future exhibitions

In what extent would you like a future exhibition to display:	Mean values, future exhibition (latest exhibition)	Std. deviation
Experiences of everyday phenomena	4.48 (4.09)	0.61
Science in society	4.29 (3.89)	0.77
Scientific facts	3.98 (3.94)	0.93
Gender issues	3.98 (2.77)	0.89
Science in a technical perspective	3.98 (3.69)	0.82

How modern science is generated	3.97 (2.59)	0.86
Controversial issues	3.94 (2.60)	0.93
Values in society	3.91 (2.75)	0.76
Science in a historical perspective	3.86 (3.22)	0.86
Science from other cultures	3.75 (2.09)	0.91

TABLE 4: Images of science related to how the respondents would like to display science in future exhibitions

Science, technology and culture	Science debate	Informative science
Science from other cultures (0.87)	Controversial issues (0.85)	Scientific facts (0.88)
Gender issues (0.66)	Values in society (0.78)	Science in society (0.80)
Science in a historical perspective (0.63)	How modern science is generated (0.69)	
Science in a technical perspective (0.57)		