1. Introduction

The so-called deficit model explains the general public’s negative attitudes towards science and/or certain scientific applications (such as genetically modified food, nuclear power, or nanotechnological cosmetics, for example) by referring to the public’s scientific ignorance. The model rests on three assumptions: First, the public holds negative attitudes towards science and/or certain scientific applications. In other words, many or at least some members of the general public are unwilling to use or (even) allow certain scientific applications in their surroundings, or many or at least some members of the general public have a more general mistrust of science. Second, the public is ignorant of the relevant, basic scientific facts. Even though this assumption might be easily understood as a normative claim that members of the general public should know more, it is in this paper understood merely as a very weak claim that the level of scientific knowledge is higher among scientists in general than among the general public. Third, the basic idea of the deficit model is that the lack of knowledge is the main or sole reason for the negative attitudes. If the general public knew more, it would also be more willing to accept the scientific applications (and/or the science) it opposes.

The deficit model was coined by social scientists in the 1980s to highlight presumptions behind the common policy of trying to build science support and acceptance by informing and educating the general public. Thus, it is also inextricably linked with a fourth assumption, i.e. that attitudes of the general public can be modified by educating and informing the public about the basic, relevant scientific facts.

Moreover, the deficit model rests on a very fundamental assumption that the negative attitudes of the general public (and not the more positive attitudes of scientists and some members of the general public) are the ones that call for explanation. The negative attitudes are then seen as mistaken or at least as some kind of anomaly. In the extreme, the deficit model may even be connected to the technological imperative. According to this line of thought, since technological possibilities will realize in any case, negative attitudes and opposition towards them are likely to cause many kinds of problems. Therefore, in order to find ways for diminishing the negative attitudes and opposition, they should be explained. Seen in this light, the theoretical basis of the deficit model is far from value neutral.[1]

In the subsequent academic literature, the deficit model has been greatly criticized on theoretical and empirical grounds (see for example Wynne 1991; Ziman 1991; Evans & Durant 1995; for brief reviews of the common criticisms see Sturgis, Cooper & Fife-Schaw 2005, 33-34; Sturgis & Allum 2004, 57-59). As a consequence, the level of scientific knowledge is rarely presented as the sole or main reason for the public's attitudes towards science and/or scientific applications in academic literature. However, despite the low status of the deficit model in academic literature, in practice it still shapes the views of many scientists and remains a common mindset in science communication and public engagement (Gaskell et al. 1999, 386; Sturgis and Nick Allum 2004, 57; Dickson 2005, 2; Hails & Kinderlerer 2003, 820; Marris et al. 2001, 78; Wynne 2006, 214-217; Jauho 2009). Tania Bubela et al., for example, state that

a still-dominant assumption among many scientists and policymakers is that when controversies over science occur, ignorance is at the root of public opposition (Bubela et al. 2009, 514-515).

Thus, the deficit model remains an interesting topic of investigation and analysis. In this paper, we analyze the deficit model, its common criticism, and the factors offered as replacement of the ignorance in alternative explanations. We claim that explanations relying on these factors may sometimes implicitly reintroduce the deficit model type of thinking. We suggest that the main problem of the deficit model is that it does not acknowledge moral values, which we argue to play a central role in many common disagreements concerning acceptability of science and/or certain scientific applications. As an instance of this, we analyze two common types of arguments against genetically modified organisms.

2. The common criticism

The deficit model is commonly criticized for oversimplifying the connection between scientific knowledge and attitudes towards science and/or certain scientific applications. If ignorance were the sole or main reason for negative attitudes, then the public should oppose the most when their level of knowledge is the lowest and have the highest level of acceptance when their level of knowledge is the highest. Several empirical cases go against this (Marris et al. 2001, 79; Bucchi & Neresini 2002, 261; Evans and Durant 1995; Ziman1991, 103). George Gaskell's and his colleagues' analysis (1999, 386), for example, shows that people in the US are much more willing to accept genetically modified crop plants than people in the Europe, even though the Europeans' knowledge level regarding genetic modification is higher.

Nevertheless, the problems of the deficit model do not imply that level of knowledge is totally irrelevant or that it has no effect on attitudes. Thus, a good critique of the deficit model consists of claiming that ignorance has been given too great a role in explanations concerning the negative attitudes of the general public. Other relevant factors should be taken into consideration to a greater extent. The commonly proposed other factors draw on ideology, social identity, trust, culture, economic factors, age, education, social and political values, risk perception, and worldviews of the general public. (See for example Bonny 2003; Gaskell et al. 1999; Kahan et al. 2009; Pardo et al. 2002; Scheufele 2008.) The basic idea then is that these many factors together with the level of knowledge form a sufficient explanation for the attitudes of the general public. To quote Bubela et al.,

the narrow emphasis of the deficit approach does not recognize that knowledge is only one factor among many influences that are likely to guide how individuals reach judgements, with ideology, social identity and trust often having stronger impacts (Bubela et al. 2009, 515).

Sturgis and Allum follow the same lines in stating that it is quite clear that culture, economic factors, social and political values, trust, risk perception, and world views are all important in influencing the public’s attitude towards science. There is however, no reason to assume in consequence that scientific knowledge does not have an additional and independent effect. (Sturgis and Allum 2004, 58.)

To put it shortly, the idea of the common criticism is that the listed factors explain the attitudes better than the mere level of scientific knowledge.

3. Critique of the standard criticism

The explanations based on the proposed factors are problematic, since they sometimes implicitly reintroduce the deficit model type of thinking. Many of the proposed factors – trust, social identity, worldview etc. – either hinder individuals from adopting or encourage them to adopt certain information. Mistrust of certain information source, for example, usually causes a person to reject the information provided by the source. Similarly, to a great extent an individual’s worldview determines which pieces of information and from which source he or she adopts as a part of his or her belief system. Thus, as far as the deficit model’s basic idea that the level of scientific knowledge affects attitudes is accepted, the suggested factors may affect the general public’s attitudes through affecting their level of knowledge. To put it shortly, the level of knowledge may be affected by the proposed factors, and thus, the proposed factors may affect the attitudes of the general public by affecting their level of knowledge.

This is not to say that the proposed factors do not bring anything new to the explanations concerning the attitudes of the general public. The proposed factors do not merely guide the individual’s adoption of scientific information but also the adoption of his or her moral (and other) values. Our culture, religion, and worldviews, for example, are intimately connected to our moral values. As we will argue later, the adopted moral values may explain one’s attitudes at least to some extent. The main problem of the deficit model is, thus, that it does not explicitly acknowledge the role of moral values in attitude formation and is, thus, insensitive to the diversity of moral value beliefs among the general public. Besides the problem of introducing deficit model type of thinking, the problem of the proposed factors is that the moral values are introduced only implicitly in them.

4. Forgotten moral values

The deficit model's failure to acknowledge moral values ties it to strong and quite controversial implications. The deficit model implies either that moral values of the general public are insignificant to their attitudes towards science and/or certain scientific applications, or that the moral values behind these attitudes are common and shared by everybody. We will next show that neither of these implications holds. Moral values are an integral part of many common arguments (both) for and against science and/or certain scientific applications. Moreover, the moral values present in these arguments are not shared by all, but are rather controversial and topics of several central public and academic disagreements, such as disagreement over acceptable level of risk. Thus, as long as the arguments are seen to at least some extent affect the general public's attitudes towards science and/or certain scientific applications, the deficit model is an insufficient and inadequate explanation for the attitudes.

The distinction between scientific knowledge and moral values as presented above and in what follows is quite artificial and oversimplified. In fact moral values and scientific knowledge are intimately interwoven and many of our beliefs are partly scientific and partly dependent on our moral values. However, since the problem of the deficit model is that it does not acknowledge the role of moral values in attitude formation at all – as interwoven or as separate from scientific beliefs – we will below present a couple of arguments in a way that makes the presence of moral values explicit by presenting them as claims or beliefs quite distinct from scientific beliefs.

As examples of the role of moral values in attitude formation we will next analyze two common argument types in discussion over genetically modified organisms (GMOs for short). GMOs have evoked a great deal of controversy in Europe. The debate has been especially heated concerning genetically modified crop plants (GM crops for short) (see for example Levidow et al. 2005). Risk arguments and arguments referring to unnaturalness have been a central part of that debate. We argue that moral values are a central topic of the disagreement in both of these argument types.

5. Risks of GMOs

A great deal of the discussion about GMOs is concerned with their possible adverse effects on human health and/or the environment (for reviewed academic studies see for example Weaver & Morris 2005). Putative health risks (which may be highly improbable) include, for example, more vigorous diseases and an increase in allergies. A possible negative ecological effect is harm to non-target species, e.g. to non-pest insects.

Values are unavoidable in risk management and risk assessment of GMOs. A central role for values may not seem surprising in the case of risk management. It is a political and value-laden process in which the outcome of risk assessment is combined with economic and technological information pertaining to various ways of reducing or eliminating the risks. One object of dispute is the acceptable level of risk. Other often controversial moral (or socio-political) issues include the following: how should the (possible) costs and benefits be balanced, what preventative measures should be taken, if any, and by whom?

Risk assessment is primarily a scientific undertaking. However, Sven Ove Hansson argues that values are also present in risk assessment because:

when scientific information is transferred to risk assessment, those of the epistemic values in science that concern error-avoidance are transformed into non-epistemic and often quite controversial values (Hansson 2007, 23).

Since the aim of science (truth) and that of risk analysis (safety) differ, the standards of proof and evidence become crucial questions. Many argue that taking into account preliminary indications of a possible danger that do not amount to scientific knowledge makes a good sense. Others champion purely scientific criteria. The so-called precautionary principle which calls for early measures to avoid and mitigate environmental damage and health hazards in the face of uncertainty is at the centre of this debate (see for example Ahteensuu 2010).

According to Hansson, controversial values in risk assessment are also related to the choice of suitable objects of comparison. For example, the possible outcomes are often compared with natural conditions – with the tacit assumption that exposures lower than the natural background are morally unproblematic. Moreover, a common assumption that all risks are fully comparable and additively aggregable (i.e. that the "total" risk is obtained by adding up all the individual risks in risk-cost-benefit analysis) may be questioned. (Hansson 2007, 23-26.)

6. Unnaturalness of GMOs

Not all controversies over GMOs concern their risks. Arguments over unnaturalness of GMOs are common (Reiss and Straughan 1996, 61; Lee 2003, 2; Streiffer 2003, 37-38) and many members of the general public judge them to be central to the GMO discussion (Madsen et al. 2002, 271; Marris et al. 2001). The problem with the unnaturalness arguments is the ambiguity of the terms "natural" and "unnatural". Unnatural can be understood to mean artificial (Elliot 1997, 123; Katz 1997), non-suitable (Siipi, forthcoming), human dependent (Varner 1998, 125; Vogel 2003, 160), technologically produced (Angermeier 2000, 374), unfamiliar (Mill 1969, 400; Harris 1985, 186), abnormal (Radcliffe Richards 1984, 70; Cooley and Goreham 2004, 48, 50), being inharmonius with nature (Elliot 1997, 117; Angermeir 2000, 378), and playing God (Mill 1969, 381; Radcliffe Richards 1984, 72), for example. Not all meanings of the terms "natural" and "unnatural" are relevant to GMOs or their moral desirability. Thus, the challenge of proponents of the unnaturalness argument is to present a sense of naturalness that is both morally relevant and applicable to GMOs.

A good unnaturalness argument must contain both moral value beliefs and scientific (or factual) beliefs. The scientific (or factual) beliefs describe why and in which sense GMOs are unnatural. They may state, for example, that dependence on advanced human technologies make GM crops more unnatural than ordinary crops. The moral value beliefs describe why the presented sense of unnaturalness is morally relevant in the context of GMOs – in the above case, why dependence on advanced human technologies implies GM crops to be morally less desirable than ordinary crops.

Both moral value beliefs and scientific (or factual) beliefs have been topics of disagreement in GMO discussions. As an example of scientific belief, there have been controversies over whether GM food is as natural for human beings as non-GM food[2] and whether GM food is substantially equivalent to non-GM food. As an example of disagreement over moral values, there has been discussion over moral relevance of being natural in the sense of being original or real (see for example Elliot 1982; Elliot 1997; Katz 1997). Moreover, it has been asked whether artifactuality of our environment is a moral concern (Lee 1999; McKibben 1989).

Thus, moral values are an integral part of some central arguments in GMO discussion. Moreover, these values are not generally agreed but rather topics of academic and public discussion. Thus, as long as arguments are seen to considerably affect the general public's attitudes regarding GMOs, good explanations of those attitudes should accommodate the role of moral values.

7. Conclusions and Discussion

The main problem of the deficit model is that it does not acknowledge moral values behind the attitudes of the general public. The factors usually presented as complements or replacements of the deficit model are ideology, social identity, trust, culture, economic factors, age, education, risk perception, and worldviews. Explanations based on these factors are problematic – when presented to replace the deficit model – since they may sometimes implicitly reintroduce the level of knowledge to the explanations. The strength of these factors is that they broaden the explanations to concern also moral issues – yet, they do it only implicitly. We feel that as long as arguments are seen to affect the attitudes of the general public to a great extent, the role of moral values should be made more explicit in the explanations. As shown by the analysis of the two central argument types of GMO discussion, many central disagreements concern moral values.

Our call for making the role of moral values explicit in explanations can be seen to imply that also the public and academic discussion over acceptability of science and/or certain scientific applications should be more value oriented and value centred. Such a change in discussion might however carry a danger of a new type of deficit model – a view that moral values against science and/or certain scientific applications are an anomaly or somehow mistaken. However, at best acknowledging the central role of moral values may lead into a situation where members of the general public are allowed to give up their position as holders of mistaken or at least exceptional views. This can, nevertheless, happen only when the role of values behind the attitudes towards science and/or certain scientific applications is realized in science communication and public engagement in science.

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[1] The discussion over the deficit model type of thinking can be made more value neutral by discussing more generally the connection between the attitudes towards science and the level of scientific knowledge. We try to adopt this point of view in this paper.

[2] Naturalness is here understood as suitability. Food that is natural for x, is nutritiously suitable for x.