Education as a Means of Participation in Genetic Engineering?

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Abstract

Organising communication processes on science and technology in such a way that they facilitate participation is anything but a simple task. 'Although participation is a political virtue in and of itself, in practice it is a very challenging and often frustrating endeavor' (Fischer 1999, 298). Nevertheless, the crucial question discussed in this paper is: How can science and technology be communicated to enable critical reflection? How can it become relevant to design and decision making processes? If emancipation is the goal, would education promise a means to this end?

Many publications can be found within the social science domain calling for a change in the communication of scientific expertise in terms of democratisation. Still the question that remains is: How do we do it? Can science communication be organised in such a way that it does not fall back on the so-called deficit model and, as far as genetic engineering is concerned, does not focus on the knowledge-acceptance relation. After more than five years of running a public information service called INFO*gen*, the author and his colleagues have gained valuable experiences, which are documented through empirical research (Wieser et al. 2001). Against the backdrop of this some conclusions can be drawn and we may provide concrete recommendations for the communication of science and technology.

Aiming at participation

When asking for socially sound design [*Sozialverträglichkeit*] of science and technology, one will often get the answer that it can only be ensured through participation. A stronger involvement of users, consumers and patients seems to be appropriate to achieve a socially sound practice. The German sociologist Robert Tschiedel writes for instance, that socially sound technology design is best understood as a *process* and as a *result* of acquisition of science and technology by the public. Tschiedel calls for a general social dispose of science and technology (cf. Tschiedel 1989, 162). With his notion of 'acquisition'

[*Aneignung*] Tschiedel focuses on the participation process in socially sound technology design as opposed to acceptance of science and technology (cf. Tschiedel 1989, 172). To him this means to initiate and organise social processes where participation becomes possible and also goes along with a participatory form of inquiry: participation as a process through which the people concerned themselves acquire science (cf. Tschiedel 1989, 167).

Participation can take place on two levels: (1) on the level of development and shaping and (2) on the level of democratic decisions on such scientific-technological applications. Both opportunities for participation include communication processes which mediate between the interest groups involved. In the end it is a communication process through which we deal with science and technology as a subject matter.

Genetic engineering is a prominent example where science communication plays a crucial role. That more should be done to inform the public has been a common demand in the course of biotech controversies in many countries. The IFF/IFZ therefore launched a public information service whose aim was and still is to facilitate informed views on genetic engineering with a major emphasis on participation and empowerment. Two observations can be noted for the Austrian context: (1) the controversy over genetic engineering has brought with it a wave of science communication on the issue and (2) this endeavour for a better 'public understanding of genetic engineering' has strongly concentrated on acceptance. In other words: the framing of genetic engineering as a problem or matter of science communication focussed mainly on the fact that the public would to a very large extent reject most applications of genetic engineering. In this context I would like to refer to a European survey, which regularly describes Austrians as biotech critics as compared with other countries (Eurobarometer 58.0 2003, 14, 18).

Framing

A characteristic feature of the focus on the acceptance problem is a specific framing, which should briefly be mentioned here. In this view the lack of public acceptance is explained by a lack of information and knowledge in the public sphere. Consequently, an increase in information is seen as an adequate means to solve the problem. Against the backdrop of this concentration on the acceptance problem one could consequently ask whether knowledge and attitude actually correlate. Some studies, e.g. Eurobarometer 46.1, argue that such a correlation can be proved (cf. ibid., 1997, 35). Furthermore, the last Eurobarometer survey (2003) shows that knowledge of biotechnology has increased in Austria since 1996 (which was not the case for Europe as a whole). Austria has climbed four places (to rank 9 out of 15) and is now in the middle range. While acceptance of biotechnology has also increased, Austrians are still sceptical when compared to Europe as a whole. Of course, on the basis of such an observation of an increase in acceptance and growing knowledge alone a causal relationship of the two can certainly not be concluded. To draw such a conclusion—even if it may appear obvious—is not valid from a methodological point of view.

In accordance with other international studies (Hampel & Renn 2000, 387; Weingart 2001, 247; Wynne 1995, 369) the author found little evidence for a correlation in this matter (cf. Wieser et al. 2001, 87). Rather, more knowledge tends to lead to more differentiated attitudes. In other words, people who claim that they know more about genetic engineering are likely to find positive and negative aspects related to its application in agriculture and food production. Hans-Rüdinger Pfister, Gisela Böhm and Helmut Jungermann note that most people feel ambivalent towards genetic engineering. Again, this is a point that has been confirmed in a number of studies. Genetic engineering is a complex object of evaluation; it contains a wide variety of issues that give rise to opinions and assessments (Pfister, Böhm & Jungermann 2000, 296). And furthermore they conclude: 'We can assume, then, that the cognitive representation of genetic engineering has nothing to do with either factual or subjective knowledge. This is further evidence that there is at best only a weak connection between what you know about genetic engineering and what you feel about it' (Pfister, Böhm & Jungermann 2000, 312). The Austrian social psychologist Wolfgang Wagner notes: 'However, a lack of factual knowledge cannot be the decisive factor, since support for biotechnology appears to be higher in countries with a similar low level of knowledge. Also, the Austrian data show that people with a higher factual knowledge have a more pronounced opinion and

answer 'don't know' less often, but that nevertheless there are a considerable number of people sharply opposed to biotechnology especially in agriculture and applied to animals. (...) In conclusion, although knowledge may be important, we have to search for other factors that might have contributed to the particular Austrian set of attitudes, which refer to recent Austrian political and economic history' (Wagner et al. 1998, 22).

The point here is that such a framing which focuses on the knowledge-acceptance relation goes along with a specific form of science communication. The communication style has become known as the 'deficit model' (cf. Durant, Evans & Thomas 1992; Irwin & Wynne 1996; Locke 2002; Wynne 1991; Wynne 1992; Ziman 1991). The deficit model refers to a communication mode that concentrates on formal knowledge and aims at imparting such formal knowledge. Against the backdrop of this approach, experts only need to explain genetic engineering properly and all doubts and resistance of lay people will disappear into thin air. Within this framing the seemingly neutral element 'knowledge' serves various objectives. Jürgen Hampel and Ortwin Renn, two German social scientists note in this respect: 'The question is, however, how the knowledge of genetic engineering and the assessment of genetic engineering are linked. Behind many 'educational campaigns' one can find the implicit conjecture that reservations about genetic engineering can be attributed to deficient knowledge. Based on this assumption, there would be no rejection of genetic engineering if everyone had the knowledge of genetic engineers. One must take leave of this idea' (Hampel & Renn 2000, 386). A simple and direct relation between knowledge and acceptance cannot be assumed in their opinion. This does certainly not mean that others would not still *try* to raise acceptance through the dissemination of factual knowledge on genetic engineering.

Critique

It is obvious that a framing of the relation between science and the public, such as outlined above, goes along with an instrumentalisation of science communication as a provision for acceptance. Researchers have found much to criticise in the deficit model. John Durant (1999)—Director and Head of Science Communication at the Science Museum in London and Professor for Public Understanding of Science at Imperial College in London—summarises the critique.

(1) Science communication can be understood to follow a deficit model if it operates with a notion of 'science as an unproblematic body of sure and certain knowledge' (Durant 1999, 315). Durant criticises such a view as naive and simplistic. Especially if new and socially relevant knowledge is concerned, it becomes clear that scientific knowledge is partial, provisional and even on occasions deeply controversial. And this is precisely the sort of scientific knowledge which most likely finds its way to the public sphere.

(2) Critics furthermore point out that the public is often addressed in purely negative terms. According to the deficit model lay people are characterised as those who lack expert knowledge. Yet, it can be observed that in actual encounters between science and the public, the latter may quite often contribute informal knowledge of great importance to what is actually happening. Once again, however, John Durant notes that this knowledge is often neglected due to its lack of the imprimatur of science (cf. Durant 1999, 315).

(3) The 'deficit model is predisposed towards attributing dislocation in the relationship between science and the public to public ignorance or misunderstanding of science' (Durant 1999, 315). There are a whole range of factors, however, that contribute to such a dislocation. Durant mentions contested knowledge claims, value conflicts, clashes of commercial, social and political interests. He concludes that a large number of contextual factors exercise an influence on the relationships between science and the public. No only the distribution of knowledge, but also cultural, economic, institutional, and political aspects are important in this respect.

(4) The deficit model can also be criticised as an undemocratic form of communication. Communication can be seen as undemocratic if it creates a hierarchy between those who seemingly know and those who don't know. Such a hierarchy is based on a preference or even dominance

of scientific knowledge. Persons lacking scientific expertise—sometimes the notion of 'scientific literacy' (cf. Miller 1990) is also used in this matter—are in this view deprived of the ability to provide competent contributions. And as Dorothy Nelkin notes in this regard: 'In part, public ambivalence has been a response to the obscurity and complexity of science that appears to threaten the power of the citizen' (Nelkin 1995, 446). And furthermore she notes with reference to (Goggin 1986) that the growing importance of expertise in policy discussions seems to limit the democratic process.

(5) Finally a lack of interactive qualities has been criticised as a feature of the deficit model. Even though it is frequently talked about in terms of a dialogue, critics have pointed out, however, that the communication style is dogmatic and patronising, because it implies a 'top-down one-way communication' from scientists down to ignorant lay persons as Robert Fox calls it (cf. Fehlhammer 2001; see also Hilgartner 1990). The dialogue rhetoric is omnipresent, but whether the communicative practice has changed, too, can be doubted.

The democratic model as an alternative

Against the backdrop of the critique of the deficit model many call for alternatives that are occasionally called the democratic model (cf. Durant 1999, 315). In essence, its aim is to overcome the privileged position of scientists (and their expertise), as well as the one-way-communication from experts to lay people. What is demanded is an equal communication between scientists and non-scientists. John Durant writes: 'Where the deficit model sees formal knowledge as the key to the relationship between science and the public, the democratic model sees a wider range of factors, including knowledge, values, and relationships of power and trust, as having an important part to play' (Durant 1999, 315). In other words, an extension of science communication in terms of a true dialogue is needed: acknowledging local and practical knowledge, giving the people affected the right to a say and including contextual aspects such as values, power relations, profit interests and issues of justice, economic consequences and risk.

Consensus conferences, as developed in Denmark, can be seen as examples of the implementation of the desired democratic model. Furthermore, hearings or procedures of citizen participation as intended for environmental impact assessments (EIA), or citizen juries, citizen panels, round tables and other forms of citizen involvement. Such approaches and procedures are also known as 'participatory' or 'constructive Technology Assessment' (CTA). These procedures are usually decision oriented and thus go beyond simple science communication in terms of information transmission and knowledge dissemination. The examples just mentioned are, strictly speaking, not communication models, but rather models of democratisation. The starting point is a critique of science and technology, which in essence is calling for more participation; participation in terms of an involvement in decision-making processes.

If it is a fact that participation is the core element of socially sound science one may ask: What are the necessary preconditions for a beneficial participation? Is participation alone enough? How much would people need to know about issues they wanted to participate in? Is participation measured by the number of participants or could one think of a qualitative criterion of participation, too? However, if knowledge is seen as a precondition for constructive participation this raises the question of where to draw the boundaries. How much knowledge is then necessary and where does meaningful participation end? The question of the preconditions for participation involves some difficulties, especially if endowed knowledge is concerned. Not least knowledge and ignorance are major arguments in boundary work negotiations and strategic instruments in the governance of participation.

Despite the difficulties just mentioned the author understands knowledge of the subject matter as a positive goal without automatically turning it into a precondition for access to participation. Against this backdrop it should be asked how this aim could be achieved: How can relevant knowledge be communicated in a better way? In other words, the author asks in terms of learning processes: How could such learning processes be promoted and what are their obstacles?

The desired objective is a practice of science communication that allows us to impart knowledge and at the same time counter a style that has previously been called the deficit model. The deficit model is not only open to criticism from a democracy policy perspective, but from the learning theory perspective, too. It may be doubted that science communication organised according to the deficit model contributes to an actual increase in knowledge. The proposed alternative focuses on action relevant qualities of knowledge instead. On this basis the author will eventually ask whether and how it is possible to overcome the knowledge-acceptance logic.

How do we learn?

How do we actually learn about genetic engineering? The learning process itself is an aspect that is often overlooked in the problem framing of public understanding of science and technology. Prime attention is obviously put on the *availability* of information, i. e. on the processing and presentation of data (factual knowledge that is understood to be objective). The focus is on information *supply*, whereas the process of acquisition is neglected completely because it is taken for granted and is in any case unproblematic. But if the addressees don't contribute to such a learning process, however, this is very often ascribed to public indifference.

The assumption that if only the 'right' information was available, the acquisition of knowledge would automatically take place on the spur of the moment is actually quite old. One could call this assumption 'Cartesian'. The French philosopher Bruno Latour (2000, 11) argues that it was René Descartes who introduced the idea of the universal cognitive faculties of man to Western thinking and by which the process of knowledge acquisition loses its importance (cf. Wieser 2002). The author, in contrast, takes the view that the process of *acquisition* of knowledge cannot be taken for granted. Even so, concrete relationships to action could contribute significantly to foster the process of knowledge dissemination and therefore knowledge acquisition. In this concern there are two notions of great importance, namely awareness learning and action learning. They will be outlined in the next sections.

Awareness learning

Awareness learning is a term used in environmental education (cf. Finger 1994) and refers to a specific way of learning, which is driven by feelings of anxiety and insecurity. Awareness oriented learning processes hardly lead to an actual increase in knowledge. For the most part such processes serve as mechanisms for reducing the unpleasant effects provoked by a confrontation with topics that are perceived as threatening or uncomforting. Information serves as a coping strategy. The impression of knowing what is going on, what the future might bring and what one has to expect is comforting. Nevertheless, the ease is not sustained because it goes along with the feeling of not having received enough information and so the vicious circle goes on. The irritation largely stems from a lack of a *perceivable* change: One cannot see how the situation could be changed or even influenced by one's own effort. How could I contribute to a change? What is largely missing here is the quality of action. The willingness to act is reduced to a reaction to a situation that is understood as being given and unchangeable. Actions are not intended to change the situation itself. This is often referred to as the so-called 'social dilemma', the feeling of powerlessness and being exposed: One single individual cannot make a difference.

Action relevant learning

Learning processes which are understood as being significantly different from awareness learning are those which open up concrete opportunities for action. What counts is to shape learning process in such a way that the subject matter has concrete relationships to opportunities for action for the learners: knowledge in terms of knowing what to do. This refers to a kind of reasoning that is quite different from universality and generality. Rather it 'is intimately concerned with the timely, the local, the particular, and the contingent (e. g. 'What should I do now, in this situation, given these circumstances, facing this particular person, at this time?')' (Schwandt 2001, 208). The American philosopher John Dewey (1916) and the German pedagogue Kerschensteiner have formulated the theoretical

foundations for this way of learning (cf. Hentig 1999, 52–53). Both advocated the maxim 'learning by doing'. The basic thesis behind this approach presumes that learning motivations result from concrete action contexts. In other words, actual knowledge acquisition does not take place because the learners simply want to be informed, but rather because they want to integrate that which is 'learned' into the concrete contexts of their own action. From this point of view learning obtains a functional character. Knowledge acquisition is thus embedded into a concrete socio-cultural context in which it serves as a means to endow particular experiences with meaning. Learning needs a concrete relationship to experiences in everyday life (or to significant experiences in the past). In order to differentiate the learning processes applied in science communication it can be noted that activities which are organised according to the deficit model basically cultivate awareness learning rather than action relevant learning, especially if aspects of action are left aside. As a matter of fact, science communication on genetic engineering is largely performed in a way in which opportunities for concrete action is missing.

Recommendations for action relevant learning

The author suggests the four learning principles discussed below in order to achieve science communication that meets the requested desire for more participation through an integration of action relevant aspects. The first would be a stronger emphasis on (1) *interaction*. This recommendation is based on the thesis that meaning is never developed in isolation from social relationships, but is collaboratively created in mutual processes and, accordingly, co-constructed. Furthermore, many researchers highlight (2) the importance of *experiences* in the course of the learning process, (3) the importance of a relation to *everyday life*, and (4) that the learners have an immediate idea of concrete opportunities for *action* related to the learning content (cf. Schallies & Wellensiek 1995, 20).

As convincing as such approaches may be, the more difficult it would appear to put these four learning principles into practice; especially when learning processes address adults and when the issues concerned are as abstract as those in the field of genetic engineering. Before a suggestion for implementation is presented in this paper, however, I will explain in detail what the learning principles mentioned above could actually mean in the context of modern biotechnology.

(1) *Interaction*: Taken seriously the call for interaction requires the organisation of processes where people can enter a dialogue with the creators of modern biotechnology. The challenge would be to make engineers and managers listen to the concerns of the public rather than getting their views across. Or as Ulrike Felt puts it, to contribute to scientists' understanding of the public (cf. Felt 2001, 21). In times of globalisation and supra-national democracies it is not easy to explain what we mean by a broad dialogue with the public. Technically it is hard to imagine how 370 million (and soon even 100 million more) consumers in the EU alone should enter a dialogue. From this perspective, forms of representation combined with dissemination via mass media appear to be obvious. Nevertheless, we can argue that it can hardly be called a broad public dialogue if people watch a talk show on TV or read letters to the editor (which are sometimes fake anyway) in a newspaper. Where do people find an open ear for their concerns? How can people feel that such an ear would actually listen to what is being said?

(2) *Experience*: The category of experience is crucial for learning processes from an STS point of view. But, aren't genes too small to see and too abstract to grasp? Genetic engineering cannot be experienced directly, at best only its products or procedures (cf. Pfister, Böhm & Jungermann 2000, 296). Apparently we cannot play with them and thereby find out how they function as 'experiential pedagogy' or 'learning by doing' in Deweyian terms taken literally might suggest. What could experience mean then? Experiences relevant to science communication on genetic engineering are not so much concerned with particular laboratory exercises as with experiences that are connected to the learning processes themselves. According to Matthias Finger it is important that people find an opportunity to derive meaning from what they learn (cf. Finger 1994, 144). Meaning can be created if learning opens up concrete opportunities for individual action or if it can be related

to significant life experiences. In other words, it is important to extend the scope of experiences. Experience orientated science communication would thus mean the inclusion of life contexts of people who are taking part in the communication processes.

(3) *Everyday life*: If we ask how genetic engineering could become an everyday experience one might answer: it has already been an everyday experience for many years. This is particularly true for genetically engineered enzymes, which are applied in washing powder and food additives as well as in the pharmaceutical industry. Of course it can be asked whether the general public knows about this or not (cf. Beckwith et al. 2003, 95). However, there are conflicting opinions on whether this relation to everyday life means the existence of more or less completed applications or if this relation included practices that are open for individual shaping processes. Genetic engineering would appear to be rather distant from people's lives even though it has already quietly entered their households. Today it is no longer necessary to know how technologies function in this fact. As for modern biotechnology, the applications of genetic engineering are often not visible and for its users it is not even necessary to know that one actually uses them. Thus, a relationship to people's everyday lives does not help *per se*. Only if such relationships to applications of genetic engineering were at the same time both conscious and relevant for concrete experiences and practices in every day life would they exercise a stimulating effect on learning and communication processes. Again this emphasises the significance of concrete opportunities for action.

(4) *Action*: It is not easy to point out where people have opportunities for action in relation to modern biotechnology. Especially if these options are meant to go beyond the alternative to say 'yes' or 'no' to applications of genetic engineering, which can be found on the shelves of a supermarket. If we understand concrete individual action as opportunities for participation in the processes of developing, designing and shaping of modern biotechnology our answers may sound a little idealistic. The challenge will be to show where they actually are, how to join such concrete practices and to which outcomes they (may) lead. How would it be possible to participate in concrete practices and to which results would that lead?

Against the backdrop of the problem outlined above, the request for more relationships to action in science communication is not easy to fulfil. Even if didactical approaches are provided it is anything but simple to work out where they could be integrated and implemented in concrete contexts of learning and communication processes. How can science communication be organised and put into practice in such a way that it provides interactive and experiential learning processes relating to everyday life and focussing on concrete opportunities for action? How can science communication be organised without falling back on a style that has previously been criticised as a deficit model? In the concluding sections of this paper it will be argued that this is possible. Job-related continuing education (further training) could be a suitable setting for implementing a better science communication in the sense proposed above.

Continuing education

A few accounts can be given why job-related continuing education is understood to be a suitable framework to fulfil the standards for science communication as formulated in this text. Of course this does not mean that the method proposed would be the one and only option in science communication leading to participation. It is 'just' one opportunity among many others in which learning processes on genetic engineering can be organised, yet it is a way that allows the obsession with the acceptance problem and communication forms of the deficit model type to be overcome.

(1) The first reason in favour of job-related continuing education is its high degree of organisation. Continuing education can rely on and provides a well-established clientele. The fact that there is an already established relationship of trust between the organisers and the participants is also very important particularly for a subject matter such as genetic engineering. The German pedagogue Hartmut von Hentig also argues for the suitability of groups of professions as an organisational framework for continuing education (cf. Hentig 1999, 156).

(2) A second reason in favour of job-related continuing education is the fact that vocational activities provide educational processes with unique relationships to action. A precondition, however, is a precise definition of the respective target group. For the case of genetic engineering this means to identify groups of a profession which have to deal with applications of genetic engineering directly or indirectly (farmers, health service providers, teachers etc.). Thinking of an organic farmer—just to give an example—it becomes clear that many action relevant relationships can be found for this professional group. Be it against the backdrop of co-existence issues, be it the use of additives in the production of homemade food or be it the issue of seed or feed contamination in the course of business certifications: for an organic farmer knowledge related to genetic engineering very often has a direct or at least indirect relationship to his or her own professional practice. The more organic farmers market their products themselves, the more important becomes their ability to communicate knowledge on genetic engineering. In the course of farm gate sales, action does not only mean to be occupied with agricultural practices, but it also means to argue for one's own business. A similar need results from an involvement in an interest group or from an appointment as a representative of a farmers' association.

(3) By organising science communication on the organisational basis of job-related continuing education one could benefit from the advantage of homogeneous target groups. Such target groups are significantly different from what is often called 'the public at large'. It has often been said that 'the' public does not actually exist and that only parts of the public can be addressed. Developing an idea of who should be addressed is profitable in any case. A definition of a clientele is particularly indispensable if it is not media coverage that is at stake, but rather arrangements with an interactive character. Experiences have shown that events addressing a specific target group are much better attended than events which invite everybody in an unspecific manner (cf. Wieser et. al. 2001).

(4) Continuing education is characteristically organised in the framework of small or medium settings. It belongs to the advantages of such circumstances that they allow interactive communication processes. From a di-

dactic perspective such events usually combine lectures and discussions. Even though more generalisations cannot be drawn on the didactics of continuing education since a wide methodical variety is employed, the interactive character remains elementary for continuing education.

Although it has been argued that job-related continuing education is very suitable for the realisation of science communication aiming at more opportunities for participation some critical remarks may be mentioned as well. An integration in the framework of continuing education can only be one step in the improvement of science communication, however, it will not be sufficient on its own. The economic conditions in particular are problematic. How thoroughly a speaker can deal with the needs of a specific clientele finds its limits in the preparation of his or her contribution. The design of a target group-specific, custom-made contribution is simply unaffordable and that is why speakers usually present their standard repertoire. It can thus be classified as a success if the programme has been adjusted to the respective target group, i.e. the speaker selects from his or her repertoire what seems to be suitable for the given event. A uniquely designed input or even a complementary inquiry can hardly be expected and if so, will only be undertaken to a very modest extent—for the most part due to cost reasons.

There is still another aspect limiting participatory science communication. For the most part 'experts' on genetic engineering do not have the slightest idea about the professional practice of their audience (of course there are exceptions). An expert on biotechnology does not necessarily know much about agricultural *practice*, and does not know how to get high school students interested in a subject matter, much less how to get them excited about something. In other words, scientific experts are lay persons for the concrete contexts of action of most professions confronted with genetic engineering and its applications. Most experts cannot say how genetic engineering becomes relevant to action for an organic farmer, because he or she has usually little idea about organic farming (a similar argument has been outlined by Brian Wynne 1996).

Despite these critical remarks the author understands the proposed approach as a constructive opportunity of how science communication on genetic engineering could be developed further, most of all because one

can counter the deficit model within the framework of continuing education. How this is possible will be discussed in the concluding section of this article.

Conclusion: Countering the deficit model and going beyond it

This article took as its point of departure the democratic aim of achieving more participation through science communication. The proposed way—focussing on learning processes relevant to action—has been formulated against the backdrop of a critique of the common practice in science communication, which in social science literature has been described in terms of the so-called deficit model. Thus, is it possible to counter the critique summarised above? Coming back to the main features of the deficit model, each of these five characteristics will be questioned and we will examine if and to what extent continuing education is suitable for taking active steps against this critique.

(1) It has already been mentioned that continuing education allows communication settings which are very likely to be successful in organising interactive communication processes and which attach great importance to them. In this way science communication is not restricted to being a one-way communication process in the first place.

(2) With explicit reference to professional contexts of action, continuing education brings about a recognition and upgrading of practical knowledge relevant to the respective professions. Local knowledge is also explicitly acknowledged when it leads to the integration of non-scientific aspects into the communication processes.

(3) An integration of professional contexts of action goes along with a broadening of the notion of knowledge. Yet, if non-scientific knowledge and practical knowledge are upgraded and acknowledged this has an effect on the very meaning of knowledge. This is particularly the case if scientific knowledge itself is considered as being partial, provisional, controversial, local and context dependent. Altogether

this allows to take steps against the hierarchy between expert and lay knowledge in a constructive way, because fields of knowledge acquired in the course of professional activities can henceforth be considered as an enrichment.

(4) If 'the public' is not an anonymous mass but consists of a series of specific parts of 'the public', these publics would have to contribute specific qualities, too. Consequently, the public does not need to be understood as a crowd of people lacking scientific knowledge, but rather as experts on their own behalf. Each professional group holds knowledge which may be of great importance in connection with the application of genetic engineering. But also for science communication these groups can contribute relevant knowledge. Even though teachers do not use genetic engineering applications as farmers do, they are, however, experts in communication when it comes to making the subject of genetic engineering accessible to their own clientele: high school students.

(5) From this perspective, a relationship between science and the public cannot be seen as one of obstruction or interference, but as necessary and supportive. Knowledge of experience from different professional activities can be a valuable resource if non-scientific aspects of scientific knowledge have to be assessed. The integration of professional groups and their practical knowledge could provide a promising perspective in the development of strategies for a socially sound dealing with the outcomes of scientific knowledge. The integration of such fields of knowledge into science communication is likely to be more beneficial than the attempt to raise acceptance through mere scientific expertise, especially if one aims at socially sound technology design. The relationship between science and the public will then not remain reduced to ignorance and misunderstandings, but will increase the chances for a better, i.e. more socially sound result.

Summarising it can be said that the integration of the topic of genetic engineering into the field of continuing education is a meaningful approach, not least because it allows perspectives for participatory science communication to be explored as well. It should be pointed out, however,

that associated measures in continuing education also need proper framework conditions and adequate financial backing if they are to be put into practice in a meaningful and valuable way.

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