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Analysis of debating strategies in classroom in the field of biotechnology

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Key words : biotechnology education, debate in classroom, argumentation

Abstract :
Biotechnology applications are used in many different fields, from the chemicals industry to agriculture and from medical diagnoses to the pharmaceuticals and environmental sectors, and their repercussions are the subject of much debate. Argumentation is a key to the build-up of knowledge, and is a crucial aspect of scientific education in a democracy. The issue for educationalists is how to develop argumentation skills among pupils, so as to enable them to participate in debates as citizens. One of the main concerns is to enable pupils to identify and determine the validity of their emotional standpoints and of the arguments used by scientists, popularisers, teachers, other students and themselves.
This paper presents a method for analysing the didactic strategies that have been put forward to develop pupils' argumentation skills in the area of biotechnology. Five supporting examples are considered. Our analysis focuses successively on the social characteristics at play and on the procedures recommended. Our aim is not to make value judgements, but to attempt to produce analytical tools to support designers and users of teaching materials in making their choices.

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Introduction

Biotechnology different fields of applications generates debates. To develop pupils' argumentation skills help them to contribute to the debates. Pupils should be helped to identify their own emotional standpoint, the arguments used by scientists, popularisers, teachers, other pupils and by themselves, the validity of these arguments, the different stages in decision-making, and so on. The aim is to help pupils to identify the criteria and information which support a point of view, theirs as well as those held by others, so that they can problematise the issue. The most effective means to meet this objective is discussion (in the generic sense).
This paper describes a method for analysing didactic strategies which aim to help pupils to develop sound arguments on the subject of biotechnology. The analysis focuses successively on social characteristics and on the recommended procedures.

Five situations were analysed, each focusing on a different biotechnology application: situations ❶ and ❷ involved the set–up of a breeding unit for giant transgenic salmon (Simonneaux, 1997), situation ❸ concerned human cloning (Simonneaux, 1999), situation ❹ genetic screening (Waarlo, 1999), and situation ❺ the production of onco-mice (Harms, 1997). Each situation was developed as part of a didactics research study. Situation ❶ was initially set up as a role play within an EIBE module (European Initiative for Biotechnology Education), and the didactic design was published by Simonneaux *et al*., 1997. Its impact was compared with the impact of a classic debating situation (situation ❷) in the classroom, on the same subject (Simonneaux, 2001). Situation ❺ was included in the same EIBE module as situation ❶ (on animal transgenesis). These situations are debating situations in classroom.
In order to make reading easier, a title has been given to each situation.
Debate situation ❶: role play on giant salmons
Debate situation ❷: debate on giant salmons
Debate situation ❸: debate on human cloning
Debate situation ❹: debate on genetic screening
Debate situation ❺: debate on onco-mice

Social characteristics

Any statement or argument has a context. It is conditioned by the culture of the social group in question, socio-professional identity, and the situations and people under consideration. This is equally true for scientists themselves. Their points of view are influenced by the current scientific environment, by their commitments (private funding of research programmes) and by their personal values. It may be said that any argument has its specific context and time. Thus, the social characteristics of the situations set out for pupils have to be taken into account.

Context

One way of trying to apprehend the extent to which the knowledge under consideration is socialised is to analyse the context of the proposed situations. The idea is to identify the type of social context (company, village, locality, family, etc.) and the degree of personalisation (social groups, key socio-professional figures identified and described, interests, motivations, questions, values). The context may be local or global.

In the role play on giant salmons, the context - a village within its economic and ecological environment - is predominantly local. In a coastal village near a fishing port, Yann Le Goff, a fish farmer, is thinking of breeding salmon which have been genetically modified to grow faster and become giant-sized. He calls them Sumotoris, after the Japanese wrestlers. The local population has expressed concern about the project. A group of fishermen, consumers, members of a nature conservation organisation and conventional fish-farmers has set up a committee to fight the project. But Yann Le Goff has supporters, especially the salmon processing factory and some municipal councillors. The Mayor has decided to organise a public debate, with guest experts. Although the situation is highly personalised, several issues (ecology, human health, famine in the developing world, rules and regulations, etc.) add a broader dimension to the topic under discussion.

Debate on giant salmons addresses the same topic (start-up of a Sumotori salmon farm), but in this case, the problem is considered *per se* rather than within a local, identified and personalised context.

Human cloning is considered in a global context in the debate on human cloning. The discussion is initially prompted by quotes giving contrary opinions from pupils, ethics experts, scientists and the ‘man in the street’.

The debate on genetic screening is addressed in a personalised context, with a video showing two real-life cases in which people are confronted with cancers of genetic origin.

In the debate on onco-mice the context is a company in the grip of a financial crisis. The Pharma Company, AnyGene in Manchester used to be one of the most successful companies in the field of gene technology applied to medicine. They specialised in research into and treatment of hereditary diseases. For about eight years the company was very successful, selling the medicines produced by transgenic bacteria. During this time other companies in various parts of the world were also successful in this field of research, creating considerable competition and causing a dramatic drop in Pharma’s profits.In an attempt to overcome this problem, Pharma’s management first of all fired fifty employees, a quarter of the workforce. Secondly, it was clear that in order to keep the investors happy and to get the company out of the red and making good profits, new innovations were essential. During a “crisis meeting” researchers decided to work with mice. The aim of the researchers was to “construct” a transgenic mouse which could be used as a disease model for investigations onto the

development of the brain tumour and to try out medicines to prevent its growth. The managing director was pleased with the plans but some other members of the management team objected to them. They drew attention to a particular rule in the company policy stating that any genetic modification of mammals had to be fully discussed and decided upon by an ethics commission consisting of researchers, management and experts on ethics.

Categories of people involved

The different situations may or may not involve people of different social categories, who have individual differences. Many people of different social standing are involved in the role play on giant salmons : the fish farmer who wants to open the transgenic fish farm, the owner of the canning factory who is interested in the project, a traditional fish farmer, a master fisherman, a " with it " media studies pupil, a gastronome, a fishmonger, a leader of an environmental association, a researcher in fish physiology, a member of the Surf Rider Foundation which is concerned on ecological issues on the seaside, a young mother who is pro organic agriculture, the Mayor, an African Ph D pupil in biotechnology. Each one is characterised according to his (her) socio-professional status, his (her) convictions and questions. In the debates on giant salmons and on human cloning, there is no actors. In the debate on genetic screening, the first part of the video deals with a father and his three sons. The boys are confronted with a genetic thyroid gland cancer of their father. In the second part a girl is confronted with genetic breast cancer in her family. In debate on onco-mice, actors are less personified, they are researchers, management and experts on ethics.

Pupils' involvement

The degree to which pupils become involved is conditioned by various factors which may or may not be inherent to the situation at issue, depending on whether they feel concerned or motivated by the situation and on any constraints that may be imposed upon them (acting out roles in the role play situation, freedom to express themselves or not in the debate when they are observers, etc.), but also on their own personalities (expansive or reserved), on their social representations, on the didactic habits of their teacher, and so on.

Categories of information

Biotechnology input was supplied to the pupils in all five situations analysed. Other types of input (in sociology, ethics, economy, ecology, regulation) were provided to varying degrees or not at all, either because the relevant context was not appropriate (ecological information in the human cloning situation), or as a result of the designer's choices. It can obviously be assumed that the type of information given to pupils would be likely to influence the quality of their arguments.

Procedures

The designers suggested an approach to the teachers for each situation to be analysed. They cannot be describe in details here. They clearly differ according to the didactic choices of the designers, who thus reveal their own hypothesis on the process whereby pupils learn how to argue out a decision. The procedures suggested are summarised in the table below.

Table 1 : Comparison of suggested procedures

Situations	Role play on giant salmons	Debate on giant salmons	Debate on human cloning	Debate on genetic screening	Debate on onco-mice
Procedures	Preparation of the role play (protagonists and observers) ⇩ Performance and observation of the role play ⇩ Analysis of the role play and individual decisions argued out	Debate with all participants ⇩ Individual decisions argued out	Individual preparation ⇩ Debate in pairs ⇩ Debate between pairs ⇩ Debate between all participants	Individual preparation ⇩ Written exchanges in groups of four ⇩ Debate between all participants ⇩ Individual decisions argued out, outside school	Supervised individual preparation ⇩ Debate among the two groups involved (researchers & ethics experts) and decisions argued out ⇩ Debate between all participants

We shall now attempt to define the dominant hypothesis underlying each situation, on the basis of this formal analysis. It was assumed in the role play that the socio-professional contextualisation would make it possible for pupils to examine all the aspects of the arguments put forward. In the debate on giant salmons, it was assumed that as pupils were free to express their own opinions, they would be better able to express their arguments. In the debate on human cloning, it was assumed that the crescendo analysis of the arguments would support their reasoning processes. In the debate on genetic screening, it was assumed that encouraging a meta-cognitive approach would improve the quality of decision making on the basis of the arguments put forward. In the debate on onco-mice, the learning process focusing on an ethics-based approach was assumed to encourage reasoning among pupils.
Pupils were either encouraged or not to identify the principles (values) guiding their arguments. They may or may not be required to identify the limits to their reasoning (for example by considering the question : what circumstance(s) might make you change your opinion ?). In all cases, the individual and collective stages took place alternately. All the designers felt that social interaction and individual preparation were both essential.
The role play on giant salmons was specific in one respect, which was the emphasis placed on the post-debate stage. The aim here was to bring out the stages in reasoning *a posteriori*, to help pupils take a more distanced view, or in other words, to adopt a meta-cognitive and “ meta-emotional ” approach. The following comments were prompted by our assessments of the role play and debate on giant salmons and the debate on genetic screening.

The teacher’s role

The main difficulty for teachers is to remain neutral when leading a debate. There can be a bias in pupils’ arguments stemming from their institutional relationship with the teacher (“ it might be as well to agree with teacher ”, and in any case, pupils will always attempt to figure out their teacher'’ opinion and will explicitly ask for it at the end of the activity).

Oral participation and arguments

The major problem in the debate was the reserve shown by some of the pupils. However, among all the studies we have conducted so far, this was the first in which we observed changes of opinion. Our previous results had not been particularly surprising insofar as opinions – as the foundations of social representations - are not easily shifted. Before and after a number of formal and informal learning sequences (visits to exhibitions), we had always found knowledge being appropriated without any changes of opinion. But in these situations, the pupils had not been asked to discuss issues orally. Could it be that it is in actually expressing points of view and being confronted with opposing arguments that we clarify our thoughts on a given subject, as asserted by Barnes & Todd (1977) and Lewis et al. (1999) ? If so, the didactic strategy involving class discussions, whether through role play or debate, would seem to be a useful way of helping pupils to develop their arguments.

Conclusion

In this field, there is no single reference argument resting on an expert's point of view. This highlights the importance of values in pupils' arguments. The quality of arguments seems to depend on the context given, on the application under consideration and on the didactic strategy being used (and particularly the multidisciplinary input supplied).
We described the issues underlying this analysis in our introduction : to propose tools to help educational designers and users to support their choices. We conducted a formal analysis of the situations put to pupils, i.e. of the scenarios containing stage-by-stage descriptions of the tasks to be performed by the pupils. This *a priori* formal analysis cannot include the changes that are bound to be made in scenarios in a school situation (before the teaching sequences take place, user-teachers will adapt the material proposed according to their priorities, their personalities and to whether they decide to work on their own or in a multidisciplinary situation : the resulting adjustments to the scenarios during teaching sequences is where the wealth and flexibility of teaching lies). The authors encourage teachers to adapt and change them, and even to cut out certain parts. Finally, it should be realised that whatever the strategies and situations used, neutrality can never really be achieved. Points of view will always pervade whatever may be stated. The issue in this kind of analysis is to help designers and users to become fully aware of the choices they make and of the forms that reveal or support them.

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