

Cognition, knowledge, understanding, participation: students' cognitive levels

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In archaic peasant societies contact with the natural elements was more direct and the *locus* of education was the family workshop: that was the school and the main question was the transmission of knowledge. Only very few privileged people had access to schooling. This framework remained unchanged up to the beginning of the industrial age, and the weight of new things to learn compared with acquired notions to be passed on was low. It was a stage when education and learning were oriented to the past.

A clean break happened with Tocqueville onwards, when societies began looking at the present instead of the past. The great change began in the 20th century, between the development of the industrial societies and the thrust of globalisation, which caused the intermingling of social, cultural, scientific, economic, industrial and political lives, and of everyone with everybody else.

Nature became a distant boundary that could be manipulated, the reality was that of biofacts, of biological products that could be and were manipulated, mixing artefacts from different realms that used to be very distinct. In these kinds of societies, oriented towards the future rather than the present and defined as Post-Modern according to Lyotard's now overused expression, education must anticipate – not follow – innovation or at least foresee innovation and anticipate its social impact and results. We happen to live in this kind of society and the school-science-society relationship must be and does become complete and complex.

And this is where the concepts of knowledge and awareness

also come in to the picture, according to the way they have been used for many years in the activities of the Cnr Project entitled *Perception and Awareness of Science*.

In order to define these concepts in relation to their meaning connected to science we have to refer to a vast literature previously examined in another similar setting (Avveduto, 2006), which is here only just mentioned in passing to define the initial concepts of knowledge, rendered as '*conoscenza*' in Italian and awareness, usually translated as '*consapevolezza*', which interest us so much since they are fused in the knowledge-awareness combination that ends up being broadly connected both to the behavioural area and to the skills area which, in this case, combine skill and competence. The need to investigate in this field is triggered precisely by the possibility of investigating the underlying skills and competences present before and after the impact of the *Perception and Awareness of Science* Project.

This project does not follow the approach of the many surveys on the public understanding of science that also measured public levels of understanding and are still carried out, although to a lesser degree. We are interested in measuring the students' level of understanding since it is a measure of their interest and involvement but especially since it is correlated to the experiences of participative communication in which they took part.

Using Bauer's tripartition (Bauer *et al.*, 2000) of the instruments and methods to measure the public understanding of science, i.e. interest in science, understanding of science and attitudes towards science, we dealt with the third possibility regarding the aspects relative to awareness/participation, leaving aside those of mere understanding, as previously understood.

However, in the surveys conducted on the water crisis and on climate and the greenhouse effect we tested the students' knowledge correlating it to the area linked to themes of knowledge and awareness by means of a few specific questions. The questions we asked the students in order to examine their specific knowledge in this field were very limited due to our interest not so much in measuring previous knowledge but in activating a system of answers to another kind of questions. However, with the obvious *caveat*, it is thus possible to correlate the greater or lesser knowledge

of the specific topic treated in the project/process of communication and perception of science with other significant indicators. Indeed, even our survey data shows that knowledge level does not invalidate interest levels.

Students were asked to reply to questions on topics that they would later study in class with their teachers and, subsequently, by taking part in the public debate.

In most cases, students showed quite a satisfactory knowledge level, replying correctly to most of the questions asked. However, when we went into detail we noticed some interesting gaps that we will examine hereunder.

As regards topics concerning the water crisis, students were presented with a range of questions covering the whole spectrum of the problem, from the effect of atmospheric agents to the impact of anthropic activities, to test their previous knowledge.

Students replied to the four questions posed to them with the values reported in Table 1.

Table 1. Previous knowledge of the water crisis. Statements of the sample on the truth of certain propositions. Total percentage values and values by gender.

	true	false
The water crisis is caused exclusively by low precipitations	11.3	88.7
<i>males</i>	13.8	86.2
<i>females</i>	6.5	96.5
Only the southern regions have been hit by the water crisis	23.5	76.5
<i>males</i>	25.0	75.0
<i>females</i>	20.6	79.4
It is impossible to predict the beginning of a water crisis	27.6	72.4
<i>males</i>	28.1	71.9
<i>females</i>	27.2	72.8
Agriculture requires considerable amounts of water	95.0	4.0
<i>males</i>	95.8	4.2
<i>females</i>	97.2	2.8

There was greater uncertainty on some propositions and we asked ourselves what made these answers more difficult to give. For example, the conviction in 23% of the sample that water problems only concerned Southern Italy might have been caused by the contingent concomitance of a catastrophic event in the South or by the widespread perception that Southern regions, which are always perceived as more fraught with difficulties, suffered greater problems also in this case.

A high degree of uncertainty was also measured regarding the possibility of forecasting events. Many students did not believe it possible to foretell when water crises would happen, which might be a sign that the culture of emergency still prevails over that of prevention.

As the data show, female students systematically gave more correct answers than male students, with considerable margins of up to eight percentage points.

The questionnaire on climate topics and the greenhouse effect gave students three possible alternatives to use as a reference to highlight the knowledge level of the topics treated. Two were of a decidedly scientific nature and one was tied to general information on the topic. Students were asked to give their opinion on the effect of the excessive concentration of CO₂ in the atmosphere, on the effect of the reduction of the ozone layer in the stratosphere and, finally, on the contents of the Kyoto Protocol.

The students' overall knowledge should be considered good, altogether better than their knowledge of the water crisis in the survey. Nevertheless, while answers to science questions were quite satisfactory, we noticed greater gaps on the information front: 12.5% of the students ignored the reference terms of the Kyoto Protocol, despite the fact that, for quite a few years now, it has been possible to find popular articles, documentaries and information sources of various kinds in the various media.

In this survey male students showed greater competence than female students, and their answers are prevalently more correct than the ones of the female students (Table 2).

**Table 2. Previous knowledge on the topics of climate and the greenhouse effect. Statements of the sample on the truth of certain propositions.
Total percentage values and values by gender.**

	true	false
An excessive concentration of CO ₂ in the atmosphere is responsible for a concentrated increase in global temperatures	90.2	9.8
<i>males</i>	94.0	6.0
<i>females</i>	85.6	14.4
The reduction of the ozone layer in the stratosphere protects the earth from the sun's ultraviolet rays	8.2	91.8
<i>males</i>	5.5	94.5
<i>females</i>	10.7	89.3
The Kyoto Protocol is an international agreement regulating trade among far eastern states	12.5	87.5
<i>males</i>	10.2	89.8
<i>females</i>	15.6	84.4

Although, as we have already mentioned, our activities did not intend to measure the degree of knowledge but to ask questions of a cognitive nature in the broader framework of the participative processes that come into play, we considered it interesting to ask the same questions to the students once the participative process itself was over, that is, after the public conference-debate and at the end of the process of debate and learning in the classroom with their teachers.

The students' answers to the questionnaires administered at the end of the process show that 78.6% of the students believed they had gained greater knowledge than what they had at the beginning. Faced with the same questions they had answered months before, at the start of the various activities of the project, the situation seemed somewhat changed. For example, concerning the initiative on climate, the knowledge gap relative to the Kyoto Pro-

tocol had been bridged and the students were able to place it according to its correct contents in 94.9% of the cases (vs the previous 87.5%). Knowledge on CO₂ concentration had also improved (94.2% of correct answers vs the previous 90.2%), while the rate of correct answers to the question on the role of the ozone layer in the stratosphere had decreased (89.1% vs the previous 91.8%). That approx. 22% of students who expressed a negative opinion on the opportunities they had had to acquire new knowledge, overall overestimated their knowledge gaps. While there were no significant gender differences in the overall perception, females seemed to have improved the most in their replies to the questions, with over 90% of them answering each of the three questions correctly (95.6% for CO₂ concentration, 93.7% for ozone, 96.4% for Kyoto).

The students' perception of their increased knowledge on the questions relative to the water crisis was more positive, with 85.3% believing they had acquired greater knowledge at the end of the entire course of the project. Females were less sure (80.6%) and males were surer (86.5%). In checking the correctness of the answers given after the whole participative process we noted that knowledge had undoubtedly improved except in one area, i.e. previous information on the causes of the water crisis.

Final conclusions

As previously pointed out, no didactic or defining intent was behind the introduction in the survey of a small part of the questionnaire aimed at testing the students' degree of knowledge on the topics dealt with in the project. As in the previous editions, we deemed it useful and appropriate to continue including an explorative area, the decidedly cognitive one, following the model of knowledge quizzes. Some authors believe that individual exercises and quizzes are an important research area in e-learning studies (Brusilovsky, Miller, 2001). Many agree on the importance – if not of a self-assessment proper – of transferring judgement on competences from outside the classroom to inside it. Indeed, this is the opinion emerging from one of the final recommendations that the US Committee on the Foundations of Assessment and the US Na-

tional Research Council considered it useful to draft at the end of a laborious study activity (Pellegrino *et al.*, 2001).

The topics treated in the course of the two editions of the *Perception and Awareness of Science* Project, taken into consideration here, have two characteristics in common: the multidisciplinary nature of the approach to knowledge, which ranges from physics to geology, to chemistry and so on, and the considerable diffusion and media impact of the recent events linked both to the water crisis and to climate change. Therefore the students, both on the school front and in the area of information and widespread knowledge, were in a favourable condition to be able to have available significant previous knowledge. Indeed, their conformity was relatively good, although their naivety and uncertainty on topics that were considered to be common knowledge are surprising.

From the point of view of a greater participation and awareness of choices as opposed to a one-way communication from the experts to the citizens, even mere knowledge aspects take on considerable importance. A correct, conscious participation cannot be separated from a high level of knowledge and culture, otherwise a problematic inability to really influence choices will come about.

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