

SCIENCE: PERCEPTION AND PARTICIPATION

edited by Adriana Valente

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*...la voix du vieux monsieur changeait sans
cesse: tantôt, c'était une belle voix d'homme
qu'on eut supposé tout jeune, une de ces
voix qui font penser à des lèvres pleines et
des belles dents. D'autres fois, c'était une
voix de jeune fille, très douce, qui riait et
babillait comme une source.*

Marguerite Yourcenar,
Comme l'eau qui coule

Summary

GUIDO BERTOLASO, Foreword	p. 9
LUCIANO MAIANI, Introduction	p. 11

FIRST PART Participation and images of science in secondary schools

1. The scientific debate on the water crisis in schools. Introductions

SUSAN COSTANTINI <i>Ethics and Polemics: the UK and Italy face to face</i>	p. 17
ADRIANA VALENTE Science and society in <i>Ethics and Polemics</i>	p. 19
LUCIANA LIBUTTI Information and education	p. 25
ANDREA DURO, GIACOMO LOSAVIO The water crisis	p. 29

2. School and participation

ADRIANA VALENTE From the Metaplan to the Open Space Technology: integrating a participated process in schools	p. 39
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MICHELA MAYER, ADRIANA VALENTE
Expressing oneself in order to participate:
tacit knowledge, learning and the Metaplan p. 43

ELENA DEL GROSSO, ALBA L'ASTORINA, ADRIANA VALENTE
Testing Open Space Technology in schools
to educate towards citizenship in science and society p. 57

LUCIANA LIBUTTI
Young people and Information Literacy p. 69

ALBA L'ASTORINA
Introducing participative practices at school: a reflection
from and with lower secondary school teachers p. 75

3. Images of science facing the water crisis and climate change. Survey results

MARIA GIROLAMA CARUSO, LOREDANA CERBARA, ADRIANA VALENTE
The kind of satisfaction you get from asking
people questions p. 81

SVEVA AVVEDUTO
Cognition, knowledge, understanding, participation:
students' cognitive levels p. 85

EMANUELA REALE
Interest, information and participation in science
and technology: evidence in the framework
of environmental research p. 93

ADRIANA VALENTE, LOREDANA CERBARA
Science: universal, independent,
but respectful of human values p. 103

ADRIANA VALENTE, LOREDANA CERBARA, MARIA GIROLAMA CARUSO
Pathway and prospects. Science as a profession p. 117

SECOND PART
Communication, science and...

ADRIANA VALENTE
Like the button game p. 133

...ethical issues

ROSSELLA BONITO OLIVA, Ethics p. 139
ENRICO ALLEVA, AUGUSTO VITALE, Behavioural studies p. 142
FABRIZIO RUFO, Bioethics p. 144
LILIANA CORI, Epidemiological research p. 147
DANIELA LUZI, ROSA DI CESARE, Open Access p. 150
GIUSEPPE SANGIORGI, Institutions p. 153
ANDREA CERRONI, Anti-science p. 156

...media issues

PIETRO GRECO, Radio p. 161
CLAUDIA DI GIORGIO, Magazines p. 163
PIO CEROCCHI, Media p. 166
NADIA TARANTINI, Creative writing p. 169
MARCO FERRAZZOLI, The press office p. 172
ROMEO BASSOLI, Affection p. 175
NADIA ROSENTHAL, Passion p. 178

...education and edutainment

SILVIA CARAVITA, Learning p. 181
ELISABETTA FALCHETTI, Museums p. 185
VITO FRANCESCO POLCARO, Astronomic observatory p. 188
EMILIO BALZANO, Education p. 191
CLAUDIA CECCARELLI, Collaborative systems p. 194
MANUELA ARATA, Not just a festival p. 197
SYLVIE COYAUD, Blogs p. 200
ANNA PARISI, TOMMASO CASTELLANI, Science cafes p. 202

The authors p. 205

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Pathway and prospects. Science as a profession

Adriana Valente, Loredana Cerbara, Maria Girolama Caruso

Images of science and scientists

Some of the questions we asked the girls and boys of Rome and Milan were aimed at examining their perception of science and scientific experience gained thus far, as well as understanding the dynamics involved in choosing their future profession: in short, how probable do girls and boys think it is that they, in some way, will become part of the scientific world one day?

The data at our disposal, besides some direct questions on the topic we were focusing on, was also completed by important information on the socio-cultural context in which these girls and boys live, to help us understand their attitude towards science and scientists. Indeed, the image of science that each of us has undeniably depends on several factors, among which we undoubtedly need to consider one's education and schooling as well as one's family background, in terms of the cultural, economic and also social level in which this education took place. In another paper we had already pointed out the difference between the individual representation of science (image of the scientists) and the collective one (perception of the research system) and were able to verify the distance between these two worlds (Brandi, Cerbara, Misiti, Valente, 2005). Therefore, in the current survey, we took these reflections for granted and formulated our considerations on the basis of them.

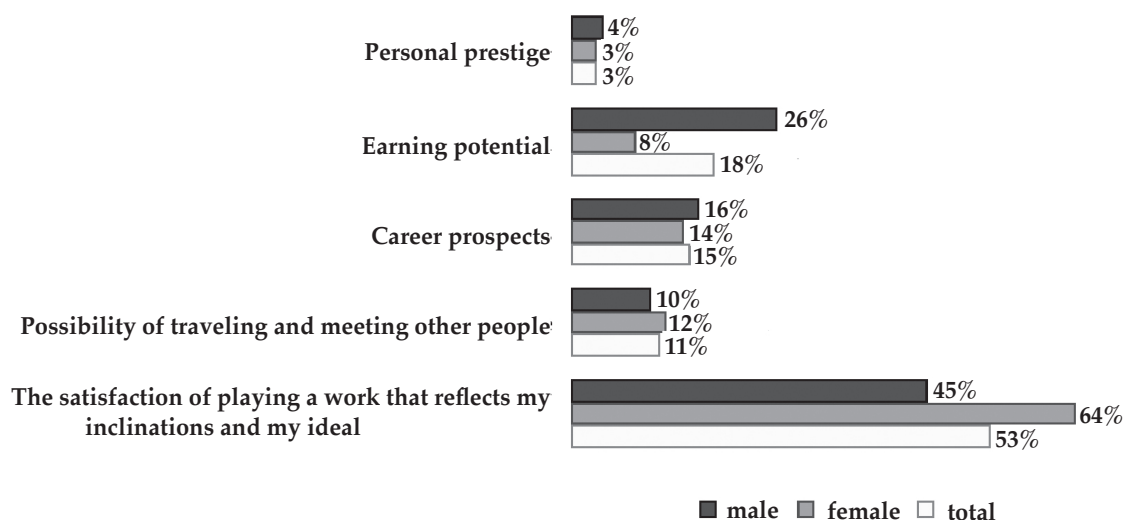
In general, girls and boys affirm that they love studying science (86% of the total of the interviewees). This datum is in line with another survey carried out on male and female students who were taking part in the *Scientists and Students at the Auditorium* Project or-

ganised in Rome during 2007 by the Cnr Press Office, in between our two initiatives on ‘climate change’ and the ‘water crisis’ (Valente, Cerbara, 2008).

Slight gender differences exist: counter to popular belief, but in line with the survey mentioned, girls seemed slightly more attracted towards the study of science, with 90% positive statements. Gender differences were evident only in some of the disciplines that we chose to put to the attention of the youngsters. For example, physics was more appreciated by boys, while girls preferred biology.

The choice of one’s future profession mainly depends on the satisfaction that it can offer (as 53% of the sample explained), and also on earning potential (18%), career prospects (15%) and the possibility of travelling (10%). Personal prestige is much less important (3%) (Fig. 1). It is interesting to note that the low level of consideration attributed to prestige also appeared in other surveys (Valente, Cerbara, 2008; Brandi, Cerbara, Misiti, Valente, 2005), in which we asked young people and students a similar question: what is the main motivation of people working in science? Even in those surveys, prestige placed last. We will come back to the concept of prestige – and to how much prestige is attributed to people working in science – further on.

**Figure 1. The choice of the future profession
Cnr data, Science Communication and Education**



Returning to where we left off, the youngest students – those of the lower secondary schools – although largely following this ranking, expressed their desire to grow up by giving great importance

to working trips (20%). The boys showed a marked practical sense since income (26%) was quite important for them (above average), while the girls assigned an absolute first place to personal satisfaction in choosing their future profession (64%). Over 62% would work in a scientific institution (with no major gender or age distinctions) and around 55% thought that he or she would be capable of doing so. This datum is in line with our expectations: in the survey carried out in 2007 within the *Scientists and Students at the Auditorium* Project (Valente, Cerbara, 2008), we found exactly the same percentage of students who would have liked to carry out research activities in a scientific institution and an almost identical percentage of those who felt capable of it.

Vice-versa, in the national survey on youngsters and science carried out by the Cnr in 2004, only 50% wished to work in a scientific institution (Valente, Brandi, Cerbara, Misiti, 2005), even only hypothetically, while few (57% of those who gave a positive answer, that is half of half) felt capable of being able to. Regrettably, the different approach of the current surveys compared with the one carried out four years ago does not authorise us to hope in an increase in possible future scientists, which is essentially due to the fact that, in the first survey, we had addressed the entire population, students and non students, from 18 to 29 years of age. On the contrary, the subjects of our latest surveys were male and female students of secondary schools who had, among other things, very motivated teachers who involved them in extra-curricular hands-on science projects. Therefore the hypothesis that good schooling contributes to the fact that young people consider the possibility of becoming scientists one day seems to take on greater solidity, although they are not always aware of it and schools do not always explicitly show them interesting career opportunities in the scientific sector (Valente, Cerbara, 2008).

It must also be pointed out that, in the ongoing surveys (Table 1), male and female students showed a certain consistency of views because three quarters of those who stated they were interested in working in a scientific institution also thought they could actually do it, while those who would have been interested in a similar job but did not feel capable of it were just a quarter of the total. Vice-versa, 73% of those who did not want to work in a scientific institution did not even feel capable of it.

**Table 1: Distribution of the interviewees by percentage according to the replies given to two questions
Cnr data, Science Communication and Education**

		Do you feel capable of it?		Total yes
		yes	no	
Would you like to work in a scientific institution?	yes	76	24	62
	no	27	73	38
Total		57	43	100

Girls and boys are aware that becoming scientists entails sacrifices (84%) but is also worth it (84%). Once again, the result of the abovementioned surveys is confirmed and shows that scientific jobs, in the collective imagination, possess a dignity that derives from the sacrifices and efforts of those who devote themselves to them; a commitment largely repaid more by the social usefulness that this profession may have, than by income in the strict sense, because around 45% of girls and boys believed that scientists in Italy earned little.

«Who is more useful for society?» Physicians and scientists win hands down.

The profession that is considered the most useful is that of the physician (57%), especially by girls (70% of consensuses) and a little less by boys (49%), and this confirms the trend recorded by national and international surveys: the first place is taken for granted for all those who work in the medical sector, especially by females (European Commission, 2001; European Commission, 2005). Scientists rank second (26%), and here boys catch up in part (29% for boys and 21% for girls).

Almost no one (less than 35) finds politicians and journalists useful, and even less preference is given to sportsmen and artists. However, some of these professions do have another chance (Table 2). Indeed, in the current survey we decided to distinguish social usefulness from *prestige*, that is to say from the consideration one enjoys in society, which bestows authority and which frequently brings with it the privilege of being aware of belonging to a golden

élite that has a certain status or power (political, economic or of another kind); it is some sort of social illusion, from the Latin *praestigium*, but which normally goes hand in hand with the perception that some sort of dexterity has determined it, as is the case with conjuring tricks (*giochi di prestigio* in Italian).

**Table 2. Usefulness and prestige
Cnr data, Science Communication and Education**

Usefulness and prestige	Usefulness			Prestige		
	girls	boys	total	girls	boys	total
lawyer	2	6	4	21	15	17
politician	2	3	3	33	30	31
scientist	21	29	26	12	10	11
entrepreneur	1	6	4	9	9	9
journalist	2	3	3	4	2	3
artist	1	1	1	6	8	7
sportsman	1	3	2	6	20	15
physician	70	49	57	8	6	7
	100	100	100	100	100	100

Thus, if we consider prestige, physicians (7%) and scientists (11%) have to give way first of all to politicians (30%) and then to lawyers (17%), although the youngest Milanese students are less convinced and divide their preferences almost in half between politicians (25%) and lawyers (24%). Sportsmen do not do too badly, but only in the boys' eyes, 20% of which consider it to be the most prestigious profession.

Although we were aware of the difference between the concepts of usefulness and prestige, which is why we posed the two questions separately, we were impressed by such a wide and partly unexpected gap that young people attribute to the two, and to the professions involving one or the other. In our opinion, this is an important datum that should provide food for thought on our society's values and myths.

Finally it must be noted that artists and physicians shared 7% of the preferences, while journalists obtained the least, and their level of usefulness increased only slightly, reaching 3% with difficulty¹.

Imaginary and projections

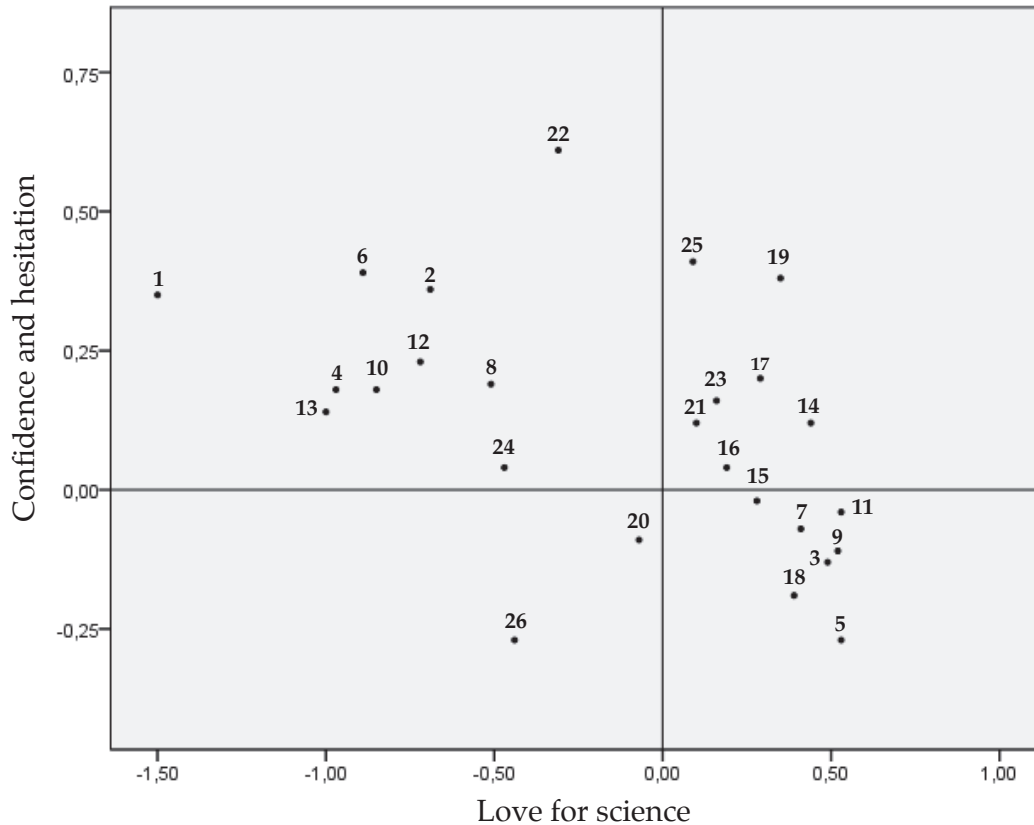
The analysis techniques available today enable a cross-reading of the data deriving from the questionnaires. This helps us grasp the latent information in the data, which is invisible in the case of a simplified reading. This type of information is often very important and can answer various questions that are the object of research hypotheses. The technique that we considered the most suitable for the available data is the analysis of multiple correspondences², a type of factorial analysis that enables the study of the relations between variables, uncovering the significance that derives from their interaction.

The first two factors were considered, which on the whole explain 12% of total variability (that is, of the original information): the first 7% and the second 5% (Fig. 2).

¹ In the 2004 national survey on *Young People and Science* we had asked which was the most *important* profession for society (leaving aside the obvious option of the physician). The consensuses were divided between entrepreneurs and scientists. In the ongoing surveys, in which we distinguished usefulness from prestige, entrepreneurs are considered a useful profession by little over 3% and a prestigious one by little over 9%. The difference between the two results is attributable in part to the fact that in the ongoing surveys male and female students gave answers at the opposite ends of the spectrum, concentrating their consensuses on few options, and partly to the fact that in 2004 we had addressed a higher age group of youngsters and almost youngsters (18-29 years old) which included workers as well as students.

² This is a multivariate technique of data analysis that enables a reduction of the available variables on the basis of a specific algorithm. The result obtained depends on the variables added to the analysis as 'active', i.e., which actively participate in the formation of the latent factors. Other variables, defined as 'illustrative', are considered only *a posteriori* with respect to the identification of the latent factors and serve to better determine the characteristics of the individuals to whom latent variables are associable. The validity of the synthesis generated by the factors on the basis of the original data is measured in terms of variability explained by the factors themselves expressed as a percentage. As a bibliographic reference, among all the existing ones, we suggest Greenacre, 1984.

Figure 2. Imaginary and projections



- 1 Do you like scientific studies? NO
- 2 Hated school subject PHYSIC
- 3 Preferred school subject BIOLOGY
- 4 Hated school subject BIOLOGY
- 5 Preferred school subject CHEMISTRY
- 6 Hated school subject CHEMISTRY
- 7 Preferred school subject MATHEMATICS
- 8 Hated school subject MATHEMATICS
- 9 Would like to work in a scientific environment
- 10 Wouldn't like to work in a scientific environment
- 11 Would you be able? YES
- 12 Would you be able? NO
- 13 Is it worth making sacrifices? NO
- 14 The most useful and prestigious profession: SCIENTIST
- 15 Do you like scientific studies? YES
- 16 Is it worth making sacrifices? YES
- 17 Choices determined by: SATISFACTION
- 18 Preferred school subject PHYSIC
- 19 The most prestigious profession: POLITICIAN
- 20 Male
- 21 Female
- 22 The most prestigious profession:ENTREPRENEUR
- 23 Scientists are underpaid
- 24 Choices determined by: EARNING
- 25 The most useful profession: PHISICIAN
- 26 Scientists are well paid

Love for science

The first latent factor determined by this analysis is a variable that synthesises love for the study of science and the good disposition towards the scientific profession. The higher the values of this synthetic variable, the higher the degree of enthusiasm for the world of science. Indeed, it highlights the contrast between those who are 'reluctant' to study science and those who are 'inclined' towards it: the former are in the negative semiaxis, the latter in the positive one.

Negative semiaxis: the side of those who are 'reluctant' is determined mainly by their negative replies to the following statements: you like scientific studies, you would like to work in a scientific environment, it is worth making sacrifices to become a scientist and includes *hated* school subjects such as physics, biology and maths. Finally, the conviction prevails that scientists earn a lot and that the choice of one's future profession is to be made on the basis of the highest income potential.

Positive semiaxis: on the contrary, on the positive side of the axis we find those whose replies showed they had the most open and favourable opinions of science and a greater knowledge of the difficulties linked to the profession of the scientist. The profession of the scientist is considered prestigious and very satisfying but underpaid. The people in this group are also convinced that it is worth making the sacrifices that a scientific profession entails and believe they will be able to undertake it themselves. They obviously affirm to be very gifted for scientific subjects.

These illustrative values help us to better determine the characteristics of girls and boys who identify with this latent variable. For example, boys are better represented on the negative side, especially if they are younger or if they go to a technical school, while girls are more frequently on the positive side, especially older girls and those who go to a scientific high school. Often they are sons and daughters of teachers.

Confidence and hesitation

The second factor is a synthetic variable that represents the level of confidence that youngsters boast of towards their future. The greater the values of this factor, the greater the conviction

that they can determine their own future by making the most advantageous choices for themselves, from the financial and personal prestige points of view. Therefore, this factor divides those who are aware of their own capabilities and choices from those who are still immature and unable to decide.

Negative semiaxis: this is where a lack of replies prevails, signifying the impossibility of taking a stance even though a certain fondness for school subjects such as chemistry is expressed.

Positive semiaxis: this is where a wide-ranging confidence in one's own future is expressed. The profession of the entrepreneur, but also that of the politician, are considered prestigious while the most useful profession is that of the physician. They are against the study of scientific subjects and believe that the most important factor for choosing their profession is personal satisfaction. They are convinced that becoming scientists entails a number of sacrifices that they would not like to make, because they believe they are not capable of them.

The structural information at our disposal tells us that the negative values of this latent variable are characteristic of the youngest students, especially boys, and those who are still immature and incapable of making decisions on their own future. Positive values are generally associable to the oldest girls who go to classical and scientific high schools and belong to double-income families.

Conclusions

This investigation has confirmed, in good part, the results of our previous surveys, but has also highlighted some contradictions that stimulate new ideas for reflection. One of these is the different perception of *usefulness* and *prestige* and the negative meaning attributed to the latter. Moreover, a breathing space is introduced, related to the motivation that leads young people to a professional choice.

Considering the criteria for choosing the future profession, the young put first the satisfaction of playing a work that is suited to their own inclinations and their ideals, and only in the last

place the prestige. The factorial analysis adds new elements for reading the data, showing the contours of two sub-groups, which are limited in quantitative terms, but which clearly connote with respect to a set of features revealed by the analysis: in fact, the components of the two sub-groups answer on a fairly consistent way to a number of questions. Those who give more importance to earnings as a factor in the professional choice, and who at the same time believe that the scientist gains a lot, are also those who wouldn't work in a scientific institution and for which it wouldn't be worthwhile to support the sacrifices to become a scientist. Conversely, those who love the study of science and who believe that the scientist gains little, but nevertheless consider useful and prestigious the profession of scientist, are the ones who would work in a scientific institution. The apparent contradiction of the former shows that even if they consider the earnings as a prerequisite in the choice of profession, it is not sufficient, and the lack of love for science is the great obstacle to the choice of the scientific profession. The latter, especially girls who love science, they are available to undertake the profession of scientist, although aware of the low gain and the sacrifices which they encounter. Therefore, a subset was identified consisting of girls that, in spite of being traditionally hardly enrolled in science and engineering, are highly motivated on the basis of interest and attractiveness exerted on them by the science and on the basis of some contextual factors – school and families. This is in line with what was outlined in the comparison between countries performed by the International study Rose in terms of social significance, that is the image and the role that science plays in society and the possibility of finding in science the values of each.

Aspects related to social significance seem to have an impact in both cases: for the former, in fact, the most prestigious profession is the entrepreneur and the most useful the athlete, while for the latter the scientist is the most useful and prestigious profession. Our survey shows the importance of the concept of social significance, even when referring to specific contexts: in fact, increased provision for the sciences is found in students whose parents are teachers and in girls who attend “liceo scientifico” high school. Do not think however that these considerations are sufficient to

explain the so-called 'crisis in scientific vocations', as the awareness of low income as well as all other considerations related to science as a system – health well-being and competitiveness of the research system – (Brandi, Cerbara, Misiti, Valente, 2005) in practice will affect the choice of the future profession: moreover, if we consider that this choice is made very often in the family context (Cerroni, De Lillo, 2007).

Moreover, our analysis clarified that one has to have reached a certain degree of maturity to begin to have a clear opinion on science, because, for example, it is the youngest who are the most undecided and incomplete in their replies, especially when these require consistency. However, growing up is not enough. Even in high schools we met with cases where unfounded confidence was boasted, especially in contexts of particular social disadvantage (parents with low schooling and therefore employed in socially weaker professional positions). Of course, we should not expect to find consistency or confidence in future expectations among the characteristics of adolescents, since it cannot be considered normal at an age in which education is still incomplete. And we are not only talking about schooling, but also of that combination of experiences that leads to the formation of an individual personality at a crucial stage of growth.

Therefore, asking girls and boys to project themselves forward and see themselves as future professionals was also useful for them, and revealed to us the fragility with which they confront this stage of their lives. It is clear from the results that we gathered that much depends on the context in which one lives, on the stimuli that one is exposed to, although gender differences lead girls to adopt a more sensitive and precociously mature attitude. All this confirms the hypothesis that it is indispensable, as well as useful for individual development, to be able to expose boys and girls to positive experiences in terms of study, reflection and debate, for instance by using certain communication and participation techniques that are starting to be tested successfully. Therefore, these two surveys provided our working group with a small but positive experience in the vast landscape of adolescence, but it would be desirable to broaden the scope of this kind of initiatives, which would help boys and girls to

reflect on themselves and on their future in a useful way, thereby increasing their critical sense and probably preparing them for a positive transition into adulthood.

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