# Are PISA Science Questions Authentic According to Pupils and Teachers?

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## Abstract

*According to the current science education, the authenticity of learning subjects and of assessment questions is essential for an effective teaching of science. These ideas belong to the large framework of context-based science education [1], which underlines the important role of authenticity for both motivation and cognitive activation of learners. In the same line, the 2006 science PISA report [2, p36] insists on the "relevance to students' interests and lives" of the PISA units to assess young people scientific literacy. Although the "factual" authenticity of the PISA science units (i.e. the existence of real-life links) is undoubtable, the assumption that they are authentic and interesting to learners (in particular of secondary level I) - and to teachers - is more arguable. This contribution reports about an empirical study of pupils perceptions of the authenticity and other motivational variables such as science related interest and self-belief of the published PISA science units related to the physical sciences. Moreover, teachers were also surveyed on their assumptions on the pupils' perception of authenticity and interest related to the same units.*

*The motivational variables in question were studied on the basis of well-established instruments, within a sample of 150 pupils of secondary level I (14-15 years) and 20 physics teachers. For pupils, covariates such as gender, age and educational level were taken into account, and the results analyzed with ANCOVA. Results show that, for the available PISA units, pupils perceive interest and even more authenticity as relatively low, contrary to the basic assumption of PISA, and that there is a large gap (often by factors > 1½ of the motivation scores) to the perceptions by teachers. Furthermore, a gap is also present between teachers' assumptions on pupils' perceptions and expressed pupils' perceptions. Some possible influences (units' subjects, subject covariates) are discussed, as well as some implications of these findings for both practice and research.*

## 1. Introduction

The PISA surveys emphasize "the capacity of students to extrapolate from what they have learned and to apply their knowledge in novel settings" [2, p3]. Moreover, it insists on the "relevance to students' interests and lives" of the PISA units to assess young people scientific literacy [2, p36]. Scientific literacy is defined as the "individual's scientific knowledge and use of that knowledge […] and willingness to engage in science-related issues" [3, p8]. It should contribute to develop and strengthen interest for the sciences and technology and counteract the widespread disaffection towards these areas, a current problem in the western countries [4].

For the developments of items, PISA had to take account of the fact that the scientific curricula can be very different according to countries. Furthermore, it focalizes less on the scientific knowledge of pupils than on their competences to understand and solve scientific problems. With this background, PISA opted for questions chosen in areas of application of science which give rise to debates in the society and/or are in connection with recent technological progress the consequences of which for society are discussed.

A central issue for PISA is that these questions are authentic and motivating for young people (see sect. 2) and it is this claim that we analyze on the basis of an empirical investigation described below.

## 2. Conceptual Background: Authenticity

A quite widespread, basic understanding of authentic learning is that it should be related to actual, real(istic), genuine contexts and experiences learners are supposed to encounter. This point of view is also strongly advocated by PISA, as underlined e.g. by [6]: "real world contexts have [...] been a central feature of the OECD's PISA project for the assessment of scientific literacy among young people". Moreover, this is also the basic understanding of the variety of approaches addressed as "context based science education" [1].

PISA states two important points about "authentic contexts": First, such problems, to be encountered in real-world settings ("factual authenticity"), are usually not stated in the disciplinary terms to be learned or applied. Thus, a work of translation with terminological and conceptual reframing has to be carried out, representing a first step of cognitive activation. Second, the disciplinary content involved is "genuinely directed to solving the problem", i.e. learners can perceive that there is a real-world problem for the solution of which some content of science is necessary ("problem authenticity"), instead of the problem being just an invented, artificial occasion to practice this content. Moreover, the combination of these two features of authenticity is also supposed to be closely linked to the science related self-concept, as it should be supported by the experience of actually being able to solve real-world problems using the knowledge and competences one has acquired [3], [6].

Moreover, beyond cognitive features, authentic contexts are supposed to foster attitudinal and affective aspects, in particular interest in science. Fensham [5] states "Real world contexts from the students' lives outside of school have the potential to generate personal intrinsic interest, and their social or global significance can add to this potential an extrinsic quality to this interest." CBSE in general [1] makes the same claim about the potential of linking science education to pupil's life. There is a considerable body of international literature on the subject of authenticity in science education, which is beyond the scope of this contribution; even though restricted, the above conceptual remarks are nevertheless useful to understand the framework in which PISA takes place.

## 3. Research questions

For PISA, "authenticity" in the sense introduced above is essential both on the motivational and cognitive level. It was indeed taken into account in the elaboration of the PISA units as these were aligned with five broad areas of "personal, social and global settings" in the real life, with essential applications of science such as Health, Environment or Hazard [2, p36]. But as the issue is about motivation and cognition of *learners*, it is *their* perception of authenticity which is the essential variable, and not that of teachers or researchers. Our questions are thus: On the one hand, do pupils at the end of secondary level I consider PISA science units as authentic and linked to real life (reality connection, authenticity; RA)? Do they perceive them as interesting from a personal point of view (intrinsic interest; IE)? Do they consider themselves as performing well in science when they know the answers to these units (self-concept, SC)? On the other hand, do teachers (of the same age group) consider PISA units authentic and interesting? Moreover, as teachers are highly concerned by pupils' motivation, do they think that pupils consider PISA units authentic and interesting? For the survey, we choose the PISA units related to physical science topics, where pupils' interest is notoriously hard to achieve (see e.g. [7] or [8]).

## 4. Sample and procedure

For an empirical answer to the above questions, we have surveyed a sample of pupils and of teachers about publicly available PISA units [2]. Teachers had to pronounce themselves about the five units more or less related to the physical sciences: Sunscreens, Greenhouse, Clothes, Grand Canyon and Acid rain, meanwhile pupils were questioned about the three first.

### 4.1 Samples

Perception of these units by pupils was tested within a sample of fourteen 8th and 9th grade classes in lower secondary school in Geneva in June 2011 (*n* = 151 pupils; 70 girls and 76 boys, 5 gender not mentioned). A panel of 20 teachers involved in secondary school was also investigated.

### 4.2 Instruments

Motivational variables were assessed with an instrument well established in the literature on science motivation (adapted from [10]; total Cronbach's $\alpha_C$=0.93; IE: $\alpha_C$=0.89; RA: $\alpha_C$=0.95; SC: $\alpha_C$=0.89); for details see [11]. The instrument was translated to French and adapted to the particular situation of a survey without an actual teaching with the PISA units. Pupils had to evaluate the authenticity and the interest of three PISA units by reading them without having to answer to the items. The questions were about the connection of the PISA units outside  school , the utility of solving them for our society (RA, 7 items), the pupil's intrisinc interest about the issues treated in the and units, (IE, 7 items), the pupil's perception that he or she would be effective in learning physics through these questions (SC, 10 items).
A similar shorter questionnaire was prepared for teachers, without SC questions (as the main research questions are about the RA and IE questions). The teachers answered about five PISA units, to verify if the results could be generalized to other PISA units. All the teachers questions where  two-fold: a first part about their own perception of authenticity or interest of the unit and a second about their assumptions concerning pupils perceptions.

## 5. Results

For the results given below, motivation test scores on each sub-dimension are given as percentage relative to the maximal possible value.

### 5.1 Pupils perceptions

Data show that pupils do perceive the PISA units as not very realistic and even less interesting (RA<50%, IE≈40%,  see Fig. 1**: Pupils perceptions about three PISA units. Mot is the sum of the RA, IE and SC.**).

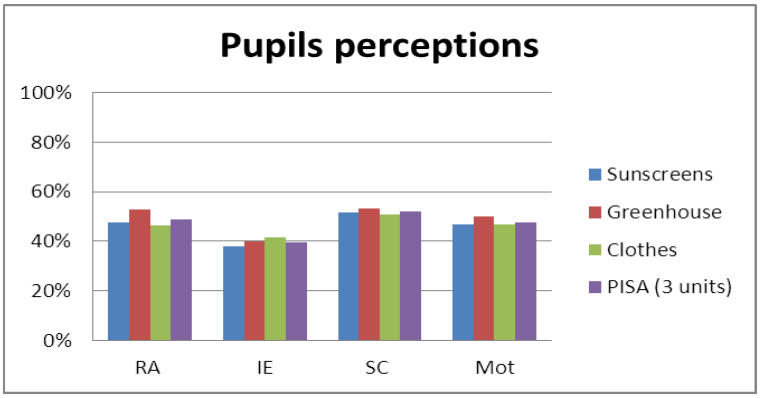


Fig. 1: Pupils perceptions about three PISA units. Mot is the sum of the RA, IE and SC.

Findings depend little on the class grade and the educational level. However the perceptions of the girls are considerable lower than those of the boys, both for RA (44% vs 53%) and IE (31% vs 47%). This result is consistent with international findings about the "gender gap" in science. motivation and interest [7, 8].

### 5.2 Teachers perceptions

The teachers' perception of the motivational features of PISA items lies considerably above that of pupils as shown in Fig. 2**: Teachers perceptions about five PISA units.**. Note that the five units' evaluation is similar to the three units' one, meaning that three units give a good evaluation for the PISA physics units.

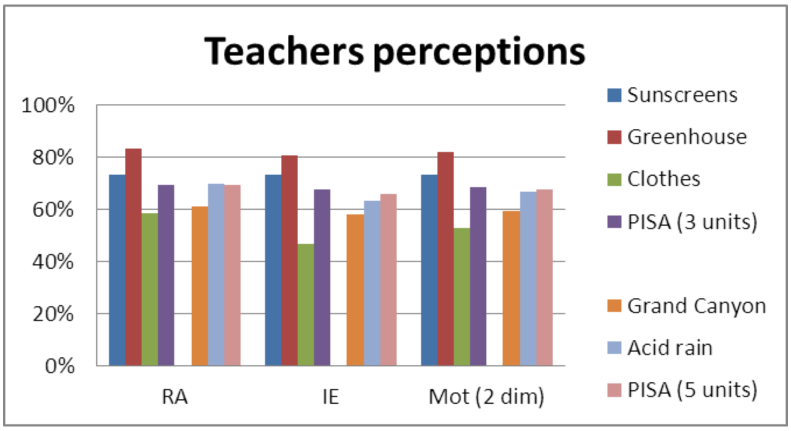


Fig. 2: Teachers perceptions about five PISA units. Mot is the sum of RA and IE.

The differences between teachers and pupils perceptions about the PISA units are all statistically significant at the level $p < 0.001$ (apart for Clothes, where no significant differences were found) and the effect sizes (Cohen d) are in the range 1.1 – 1.9, i.e. are very large according to the usual size conventions [12]

### 5.3 Teachers assumptions about pupils perceptions

Teachers are generally aware of the attitude of teenagers: physics is considered difficult and paradoxically abstract. Nevertheless Fig. 3 shows that teachers still overestimate pupils' perceptions. The significance level of differences is $p < .01$, effect size are smaller than for the preceding case, but still considerable (range 0.6 – 1.1).

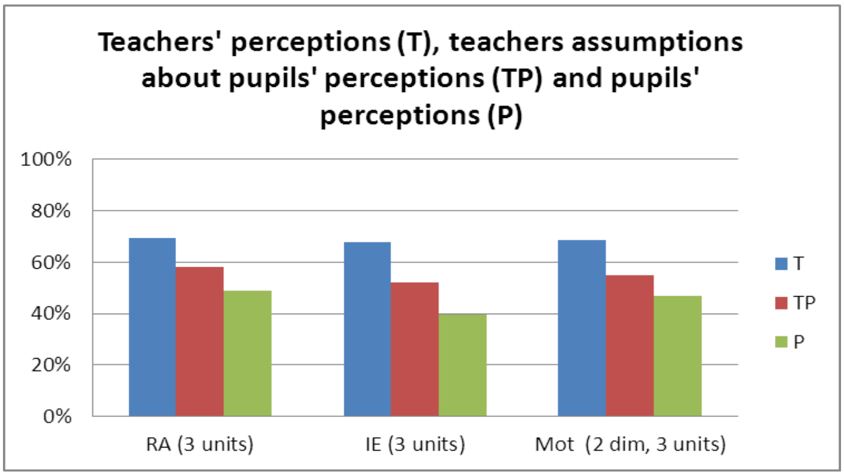


Fig. 3: Comparison between teachers' perceptions, teachers' assumptions about pupils' perceptions and pupils' perceptions.

## 6. Conclusions and implications

The perception of interest and authenticity of the physical science units of PISA by pupils of secondary level I (the PISA target group) turns out to be generally low, lower than it ought to be expected, given the large role motivating and cognitively science problems are supposed to have within the PISA framework [2], [3], [5], and the lot of care put into the development of its testing items. In particular, pupils perception of interest and authenticity is considerably lower than the perception of teachers (of the same items), and it is much lower than those which can be attained in actual CBSE teaching approaches [10].

PISA's concern of integrating learning and motivation issues is widely shared, and its findings on learning are an essential building block for the current knowledge on science education. However, the present study sheds some doubt on how well PISA actually succeeded in implementing its understanding of interest and authenticity into its assessment items. More generally, researchers interested in CBSE, and in particular hypothesizing benefits of some form of authentic tasks and learning, should not work with their own perception of authenticity, even if widespread, but assess the actual perception of their target group.

A similar statement is true for classroom practice: teachers should be aware of their tendency of overestimation of pupils' interest and authenticity perceptions, and if they are interested in developing or using some teaching approach based on authenticity, they should assess the actual perception of their pupils. This requires, of course, that they dispose of a "classroom-proof" (i.e. short and reliable) test to do so, and the present work offers (for the given understanding of authenticity) such an instrument.

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