

Studying the Process of Interpretation on a School Task: Crossing Perspectives

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In this paper we analyze situations of misunderstanding, by the mean of two analytical models: The pragma-dialectical and Grize's natural logic. Both analyses focus on a student's answer, first to an item of mathematics from PISA survey, and second to a paper-and-pencil exercise in mechanics at college. These examples provide candidate methodologies for investigating processes of interpretation about specific tasks in particular educational contexts, which may be approached as situated and socially negotiated inference processes.

education, interpretation, knowledge-oriented argumentation, natural logic, discourse analysis, perspectivism, points of view, pragma-dialectical model, situations of misunderstanding, socio-cognitive approach

1. INTRODUCTION

We are interested in the relation between the expected interpretation of educational tasks and the actual interpretation by students performing the task. In educational settings, it is indeed common for a task designer to set specific expectations in terms of task's interpretation and in terms of what students should produce as answers or solutions. However, students do not always succeed in inferring the designers' intentions and expectations. In this case, the responsibility of this failure is generally attributed to the students, and considered as a lack of knowledge or skill. Yet, before attributing students' failure in a task to their lack of knowledge or skill, one must verify wherever the task has

been understood in the same way as intended. Otherwise, there is a risk to attribute a cognitive deficit to students who are actually answering a different question or problem. In this case, the failure of the task is due to a *situation of misunderstanding* rather than to a lack of cognitive ability.

In this paper we will analyze such situations of misunderstanding, by the mean of two analytical models that allow for detailed descriptions of the mismatch between the expected inferences and the actual inferences made by students. For each analytical approach, we will present one example.

The first example provides an analysis of a student's answer in an item of mathematics from the survey PISA, an international survey that aims to assess students' competencies at the end of compulsory school. The analysis is inspired by the pragma-dialectical model proposed by Van Eemeren and colleagues and serves to shed light on the diversity of students' arguments as opposed to the arguments expected by PISA designers. The second example provides an analysis of the interpretation of a paper-and-pencil exercise in mechanics by a college (or high-school) student. Grize's model of logico-discursive operations permits a micro-scale description of the inferences of the student leading to a situation of misunderstanding.

These examples display candidate methodologies for an investigation of the process of interpretation about specific tasks and in specific situations, responding to a theoretical concern raised long ago (e.g. Perret-Clermont, 1980), and many times since. It was observed, for instance, that students may provide the expected answers or solutions and still interpret the question or problem differently from the task's designer (i.e. teacher, survey designers). The meaning of language and other signs, such as graphs or mathematical symbols, cannot be taken for granted when several interlocutors are involved. Each one may have a different interpretation of the same signs, and probably will.

A psychological investigation of interpretation processes can only be carried in relation to specific tasks and specific situations as the meaning is not contained in the signs interlocutors are interpreting, contrary to the information processing metaphor assumes. The interpretation process itself may be approached as situated and socially negotiated inference process. In this sense, argumentation theories are useful, but must also be adapted to the

specificity of a psychological investigation of (inter)subjectivity, e.g. articulating different perspectives on the same task.

2. FROM INFERENCE PROCESSES TO SITUATIONS OF MISUNDERSTANDING

The study of inference processes is generally addressed with formal logic, e.g. in cognitive science, or in reference to argumentation theories. In both domains, the analysis generally refers to norms and rules of the “good reasoning”. Yet, as Vergnaud points out, “the argumentation, as an activity, is not only made of statements and explicit arguments, but also of implicit identifications which concern the meaning given to what the other says” (2015, p.390). Analyzing interlocutors’ interpretation is an additional challenge for researchers (Plantin, 2011). Taking up this challenge can contribute to the reconceptualization of argumentation Plantin (2011) calls for, far from a rationalist approach pinpointing fallacies. In this paper, we would like to start with a descriptive approach, interested in the subjective *points of view*, in the sense developed by Piaget (Mounoud, 2000). We thus aim at describing specific interpretations or inferences about the meaning of discourse or other signs, which are situated in specific moments of a process of communication. This focus raises a challenge, both methodological and theoretical: How can we describe subjective inferences about meaning without a mere assimilation to formal models?

A close observation and analysis of critical incidents such as misunderstandings makes the investigation possible, since it works as a revealer of the subjective points of view on what is supposed to be shared in the interlocutory situation, through their discrepancies from a *third person point of view* (Kohler, 2015). In order to do so, the misunderstanding is not approached as a merely linguistic or pragmatic phenomenon, but as situational. The situation is the most micro level of analysis at which cognitive processes such as inferences can be analyzed while taking the subject's point of view in consideration. Taking childrens' points of view in consideration, Inhelder and Piaget (e.g. 1955) have shown that they use a qualitatively different rationality than the one described by formal models or used by experts among adults. This rationality is not necessarily flawed, and it is precisely one of the most interesting outcome of *genetic epistemology* to show that what makes sense for the child, regarding a specific situation, is

sometimes quite different from adult or formal logic, and nevertheless coherent. For instance, children do not always consider contradictions problematic in the sense it would require a solving in favor of one of the contradicting standpoints. These standpoints can co-exist in a child's reasoning, at a given point of his development, and only lead to further development under specific conditions. Among these conditions, social features of the situation play an important role, as firstly demonstrated experimentally – with research on socio-cognitive conflicts (Perret-Clermont, 1979) – and later developed as a *socio-genetic psychology* (Psaltis, Duveen & Perret-Clermont, 2009 ; Psaltis & Zapiti, 2014).

Inhelder and Piaget set a perspective which consisted in being interested in the actual reasoning of the child – his own “logic” in Piagetian's terms – independently from any adult-centered judgment about its rationality. The theoretical tools used by Piaget to describe this “logic of the child”, i.e. Boole's logic and predicate logic, were not made for it and laid the ground to critique which misunderstood his scientific project (Apostel et al., 1963). If the theoretical tools were not fitted with the function Piaget made them play in his work, we have reason to think that the perspective itself is not only valuable – in particular for education – but remains a challenge for future research. Indeed, not only the child uses various rationalities but also any layperson: If formal logic is relevant for computer programming, choosing your menu at the restaurant may indeed require quite a different rationality. Hence, the relevance of inference depends not only on formal criteria, but also on the situation and on the actual question or problem reflected upon. We propose to contribute to this approach here, yet making use of more recent theoretical models in the field of argumentation for the description of the particular subjective inferences made by specific subjects in given situations. Our researcher third person point of view will be based on chosen models or theory of argumentation, taking the situation for scale of analysis, in order to include cultural, historical and social processes which fully contribute to relevance of inferences. Rigotti proposes the concept of *reasonableness* (2006, p.519) for approaching the normative question of argumentation in relation to specific contexts of use.

This paper aims at describing actual reasoning and inferences of children on school tasks, in order to better understand what happens when the children's answers or performances to a task are not matching the expectations of the school system (e.g. Kohler, 2015; Greco, Mehmeti, Perret-Clermont, 2016). Therefore, we are interested on argumentation as a process, which underlines a dialogical approach (e.g. Kuhn & Udell, 2003; Kuhn & Udell, 2007; Plantin, 2005)

3. METHODOLOGY : A DESCRIPTIVE APPROACH

We have raised the issue of the relation between psychology, logic and argumentation. Grize (1982) comments this point as particularly problematic in the western tradition: The attempts of Pascal, Boole or others to study the "law of thought" raised the fear of "psychologizing", i.e. of a reductionism of the mind to psychological investigations, and was strongly opposed by scholars such as Frege. This issue is not one of argumentation theory nor of psychology, it is rather an issue of epistemology, and thus requires a response *in epistemology*. For the sake of this study, our response to this issue consists in making our epistemology explicit as perspectivist (Kohler, Lordelo et Carriere, 2017 ; Kohler et Donzé, 2017). In the perspectivist epistemology, scientific models and studies constitute specific perspectives on the object under investigation. A specific perspective may be more or less relevant for a specific research question, yet most often several perspectives are better than one. Moreover, perspective as such can be the object of the investigation: Can a specific model or theory contribute to shed light on what remained out of the scope of previous studies?

This perspectivist epistemology motivates a combined presentation of two case-studies using two different theoretical models for a similar research question. This confrontation of perspective on the same object of study not only provides descriptive results about the particular cases we have analyzed, and allows for a methodological discussion about the specificities of each models when used for the description of situations of misunderstanding. This paper is only a first contribution to a discussion of the specificity of each perspective.

4. FIRST ANALYSIS

4.1 Procedure of analysis

This first analysis aims to describe separately two different points of view on a same task. In the task description provided by the designers, the task should deliberately promote one specific type of reasoning or argumentation. Yet, from the student's point of view the task can lead to multiple interpretations. The designer's point of view is reconstructed through an *a priori* analysis of the task (e.g. Artigue, 1988; Sensevy & Mercier, 2007), based on the Pisa item, the related comments from the designers, and the evaluation criteria. The students' points of view are reconstructed with an argumentative analysis inspired from van Eemeren and colleagues' analytical approach (e.g. van Eemeren & Grootendorst, 1992, 2004; van Eemeren, Grootendorst, Jackson, & Jacobs, 1993; van Eemeren, Grootendorst, & Snoeck Henkemans, 2002; van Eemeren, Houtlosser, & Snoeck Henkemans, 2007): It allows a careful description and reconstruction of students' reasoning underlying their answers. The comparison of the two points of view allows for the identification of misunderstanding.

A first step of the analysis consists in taking into account the designers' pre-established evaluation of what are considered good answers. It is followed by an *a priori* analysis of this evaluation scheme, and with the identification of students' argumentation. This argumentative reconstruction notably allows to integrate unexpressed premises (van Eemeren & Grootendorst, 1992; van Eemeren et al., 2002, Gerritsen, 2001), that are implicit elements in the argumentation. For van Eemeren and Grootendorst (1992, p.60) "to establish precisely what someone who has advanced argumentation can hold to if the argumentative is analyzed as a critical discussion, an analysis must be carried out both at a pragmatic and at a logic level". They add that "if in the argumentation, parts of the arguments are implicit, then a logical analysis is indispensable" (ibid). This is particularly relevant in cases where the interlocutors' statements are assessed only on their explicit answers (i.e. in written tests at school). Indeed, it has the potential to reveal the interlocutors' reasoning which, in turn, allows to identify whether it follows the expected and valued reasoning or not. In this sense, we insist particularly on the *analytical overview* rather than on the stages of a critical discussion. Other authors interested in knowledge-oriented argumentation and school situations have underlined the need to

adapt the pragma-dialectical approach in the study of such situations (eg. Baker, 2015; Greco, Miserez-Caperos, & Perret-Clermont, 2015).

4.2 Summary of the situation and presentation of the data

The data we present are part of an on-going research and consist of written answers from 159 students aged from 13 to 15 years old who answers to different items inspired by one specific item from the PISA survey. The official item “Robberies” (see figure 1) concerns a mathematical problem, in which students are invited to answer to a question around a fictive situation, presenting a journalist who makes a statement on a graph that contains data on the increase of robberies.

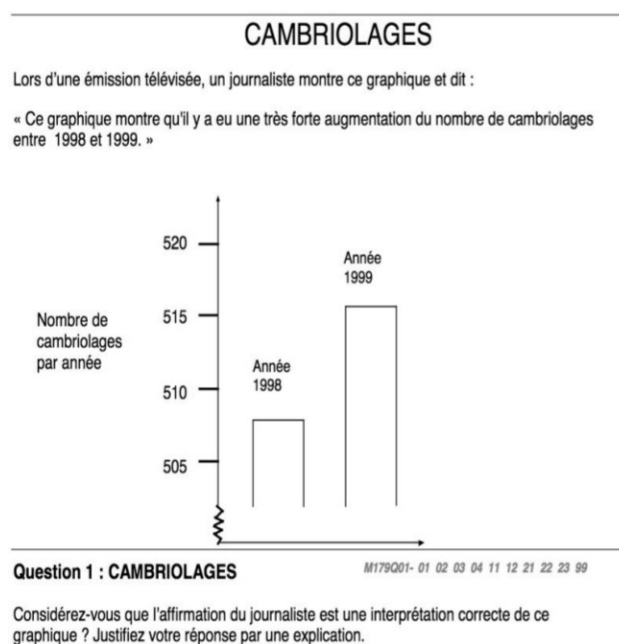


Figure 1 – Original PISA item, retrieved from <https://www.ge.ch/recherche-education/doc/pisa/codification-maths.pdf>.

Here is a translation (by the authors) of the item:

(1) ROBBERIES

During a TV show, a journalist shows this graph and says:
“This graph shows that there was a huge increase in the
number of robberies, between 1998 and 1999.”

Question 1: ROBBERIES

Do you consider that the journalist's statement is a correct
interpretation of this graph? Justify your answer with an
explanation..

This item is considered by PISA designers as a particularly difficult
one, and there is an important rate of low achievement in it
(OECD, 2009, p.300). Following the designers’ analysis, such an
item

(...) involves the analysis of a graph and data interpretation
(...) The competencies that are essential for solving this
problem are understanding and decoding of a graphical
representation in a critical way, making judgments and finding
appropriate argumentation based on mathematical thinking
and reasoning (although the graph seems to indicate quite a
big jump in the number of robberies, the absolute number of
increase in robberies is far from dramatic; the reason for this
paradox lies in the inappropriate cut in the y-axis) and proper
communication of this reasoning process. (OECD, 2004, p.82)

Although such a description of the requirements of the task sheds
light on multiple cognitive demands, we will see that the coding
scheme to assess students’ answers does not really allow for such
a critical stance from the students’ part.

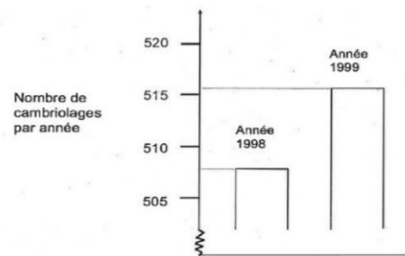
We start by presenting the designers’ coding scheme for students’
answers (see figure 8 and 9 in Appendix) and present our *a priori*
analysis of it. First, if we observe what PISA designers consider as
an answer allowing to get full points, we may observe that they
privilege students’ answers that explicitly use arithmetical and
geometrical models, on incomplete data. Students who do not use
such models are considered as failing the item. On the other hand,
a careful *a priori* analysis of the item itself allows to observe that
multiple interpretations are possible from the students’ points of
view. Indeed for instance they may interpret the task as requiring
from them : a) to take the journalist’ statement as a starting point,
and seek for arguments to defend the statement “there is huge
increase”; b) to counter the journalist’ statement and/or
interpretation of the graph; c) they may understand that one ask
them for a personal opinion d) interpret the role of the journalist

as a (un)legitimated authority in terms of interpreting/commenting the graph d) decide on which criteria to assess the journalist' interpretation.

In argumentative terms, our hypothesis is that this may correspond to an uncertainty for the interlocutors, here the students, towards the issue to discuss. Indeed, it is not *a priori* clear for the student what is the issue at stake, and as we will notice in a student's answer, this can lead to students' cognitive efforts to decipher the issue at stake. In the following case, the student's efforts to do so are visible in the *analytical reconstruction* we made of her answer. The overall data show different examples of students' reasoning which is not aligned on the designers expectations for high achievement in this item. The reconstruction of their argumentation, and more particularly the identification of *unexpressed premises*, reveals that students may sometimes even adopt the designers' expected reasoning, but as the designers' assessment is only based on the explicit answers, such answers can nevertheless get low credits. The case we chose to present illustrates particularly well the student's efforts to provide arguments in regard to two different standpoints, probably induced by the multiple meaning inferences allowed by the task proposed.

4.3 Student's point of view

Trying to answer to the question 1 in the mathematical problem (see figure 1), the following student (see figure 2 for her complete answer) first approves the journalist's interpretation, answering thus to the question of whether there is or not an increase of robberies. She then goes on by answering by "no", giving arguments in regard to the qualification of the increase as "huge" and to more contextual aspects such as the growth of inhabitants. Then, she concludes that the journalist's interpretation is not correct as "it depends on which country or which city we are. Because there will be more robberies in a big city than in a small one or even less in a village".



Considérez-vous que l'affirmation du journaliste est une interprétation correcte de ce graphique ? Justifiez votre réponse par une explication.

Oui et Non

1. Oui, parce qu'il a eu une augmentation des cambriolages.
2. Non, ce n'est pas une très grande augmentation
3. Non, parce que ça a augmenté proportionnellement parce qu'en 1998 il y avait moins d'habitants qu'en 1999.

Je pense que ce n'est pas correcte au final parce que ça dépend dans quel pays on est ou dans quel ville. Parce qu'il y aura plus de cambriolage dans une grande ville que dans une petite ou encore moins dans un village.

Figure 2 – Student's complete answer¹.

Here is a translation (by the authors):

(2) Yes and No

1. Yes, because there has been an increase in the number of robberies.
2. No, it is not a huge increase.
3. No, because it has increased proportionally because in 1998 there were less inhabitants than in 1999.

I think that finally it is not because it depends in which country or which city we are. Because there will be more robberies in a big city than in a small one or even less in a village.

In terms of what counts as a good answer according to the designers, this student's answers would not allow her get the total points. However, we can observe that the student makes many efforts to argue on the qualification of the increase as a "huge" one, calling to unexpressed premises such as the necessity to

¹ This excerpt and a first analysis of it has previously been presented for another purpose (see Mehmeti, 2016).

know much more about other meaningful factors or contextual aspects (see figure 3).

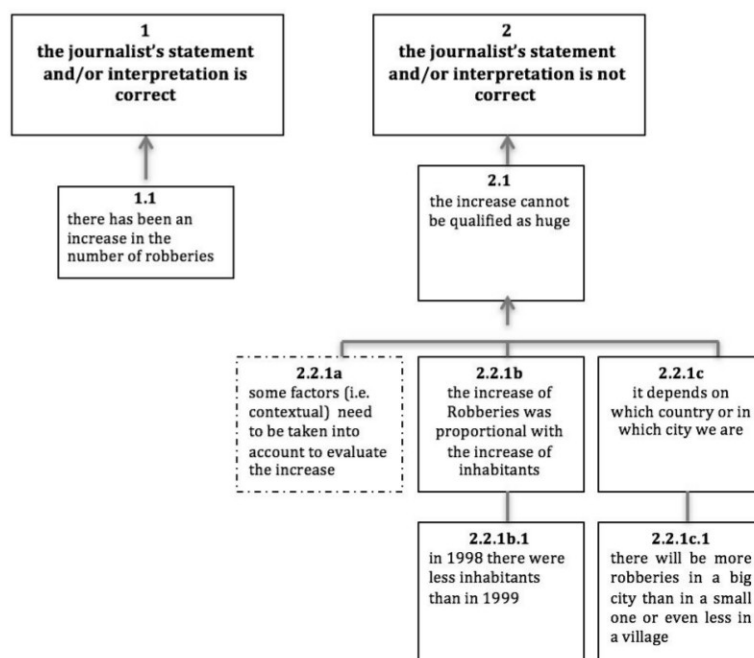


Figure 3 – Reconstruction of students' argumentation (in english) - unexpressed premises are indicated in unbold framed boxes

While such argumentation illustrates the student's efforts to decipher the *issue*, it allows to show that her answer probably does not follow the mathematical modelisation that is expected by the designers and valued as such.

5. SECOND ANALYSIS

5.1 Procedure of analysis

In this analysis, the interlocutors inferences will be described with *logico-discursive operations* (Grize, 1996). Since the actual thinking processes are to ever remain out of reach of direct observation, it is important to stress that the set of operations of Natural Logic

constitutes a model. It provides the analyst with a detailed and functional descriptive language for setting hypotheses about the cognitive activity taking place within and through a discourse. In order to study misunderstanding, it is precisely the quality of its descriptiveness that is of particular interest. It allows a rather simple methodological approach of interpretation, which we resume to three steps here.

Firstly, the analyst identifies a *critical incident* (see for instance: Hughes, Williamson & Lloyd, 2007) in reference to the context, which could be the clue to a situation of misunderstanding. In the example below, the critical incident is an answer to an exercise that is considered wrong from the teacher's point of view, and that is not easily explained by a common mistake. Several reasons can lead to a wrong answer, yet a situation of misunderstanding is one of them.

Secondly, a detailed examination of the collected data (mostly written and oral discourse) supports the reconstruction of the "micro-histories" (Tartas, Perret-Clermont & Baucal, 2016) from several points of view. Yet, in this case, the several moments of the micro-history – the "learning phases" – are not controlled experimentally. They are chosen after data collection and according to the actual opportunities provided by the course of events and the natural setting. The result of this analysis can lead to either drop the hypothesis of a situation of misunderstanding, or to identify the specific element(s) from discourses and more generally from the situation which appear *divergent* from two (or more) points of view. In the example below, the reconstruction of the student's point of view leads to the hypothesis that she has considered two exercises related while the teacher did not.

Thirdly, a micro-scale analysis with Natural Logic provides a description of the misunderstanding, which is still related to the specific content of the various interlocutors' discourse, and to the situation of interlocution. This description allows to *state*, with the concepts and language of Natural Logic, the difference in meaning from the two (or more) points of view. This *statement* remains just an hypothesis, yet the overall examination of the context, situation, and discourse at a micro-scale, may greatly support its plausibility. When accepted, the hypothesis works both as a description of the logico-discursive activity of the interlocutors, and as a scientific argument for the researcher's interpretation of

the situation under study as 'a situation of misunderstanding'. Moreover, depending on the context, such description can support comments concerning issues of concern. For instance, in the example below, the acceptance of the analysis supports comments on potential obstacles to learning related to the exercise layout, the various signs and discourse used to guide the student cognitive activity, and about what exactly are the expected learning processes in this particular case.

5.2 Summary of the situation and presentation of the data

During physics lessons, second grade college (US: high-school) students have paper-and-pencil exercises to complete individually. Since the overall instruction and its layout are relevant to the analysis, we reproduce below the entire exercise sheet² (see figure 4).

1.2 The force of gravitation

The classical law of universal gravitation has been formulated by Newton in 1685 on the ground of experimental knowledge of his time in order to explain the movement of Planets around the Sun.

This law states that the modulus of the gravitational force F between two bodies of mass m and M , separated by a distance r is:

$$F = G \frac{mM}{r^2}$$

The distance r is the distance between the center of gravity of the two massive objects and G is called the constant of universal gravitation $G = 6,67 \cdot 10^{-11} \text{ Nm}^2/\text{kg}^2$



Applications :

1. Calculate the force of attraction exerted by the Moon on the Earth.
 2. Extract the expression of g and calculate its value.
- Grven: Astronomical Data

$M_{Earth} = \dots\dots\dots kg$
 $R_{Earth} = \dots\dots\dots m$
 $M_{Moon} = \dots\dots\dots kg$
 $R_{Moon} = \dots\dots\dots m$
 $d_{Earth - Moon} = \dots\dots\dots m$

.....

² The text originally in French has been replaced by the translation by the authors, without changing the layout, mathematical expressions and drawings.

attraction force exerted by the Earth on the Moon. She uses the mathematical expression of the universal gravitational force to calculate this force, introducing the astronomical data (copied from a reference book) into the equation. The answer is given in *Newton*, the unit of measure of forces. This first answer only interests the analyst for its influence on the way the student answered the second question. It is an element of the situation that is relevant for the analysis, yet it is not what the misunderstanding is about.

The aim of question 2 is for the teacher to make students find the value of g , using the mathematical expression of the universal gravitational law. The small letter g represents here the constant acceleration of falling objects (without friction) on the surface of the Earth, and is known by student to be worth $9.81m/s^2$. To answer the second question, the student starts by using the same mathematical expression of the universal gravitational law, replacing immediately m and M with, respectively, the mass of the Earth (M_T) and the mass of the Moon (M_L). She continues by stating the equality between the force of attraction between the Moon and Earth she just specified, with " $M_L \cdot g$ ", i.e. the multiplication of the mass of the Moon with g , in reference of the second law of Newton ($F=m \cdot a$). By stating this equality, the student actually chooses to calculate g as the acceleration of the fall of the Moon on Earth. Figure 6 presents the student's answer to question 2.

$$F = G \frac{M_T M_L}{r^2} = M_L \cdot g \quad g = \frac{F}{M_L} = 9,81 \text{ N/kg}$$

Figure 6 – The written answer of the student to question 2 (untranslated).

Let us briefly examine the answer expected by the teacher to question 2. The mathematical expression of the universal gravitational law can be used for any object falling on the surface of the Earth by keeping m undefined, replacing M by the mass of the Earth, and replacing r with the radius of the Earth, i.e. the distance between the center of gravity of the mass M and the approximate location of the fall of the object of mass m . The mathematical expression is represented in figure 7.

$$F = G \frac{m M_{Earth}}{r_{Earth}} = 6,67 \cdot 10^{-11} \frac{m \cdot 5,97 \cdot 10^{24}}{(6,38 \cdot 10^6)^2} = 9,78m$$

Figure 7 - The mathematical expression of the answer expected by the teacher.

Using Newton's second law and reducing all forces applied on the falling object to the gravitational force, we can state the equality $F=9.78 \cdot m=m \cdot a$, and hence $a=9.78m/s^2$. The consequence of the choice of r as the radius of the Earth is that, g is only (approximately) worth $9.81m/s^2$ and constant *near the surface* of the Earth, and cannot be calculated from the fall of the Moon on Earth.

Now the question is where has the student's interpretation gone wrong. What is the specific inference this student may have done in her interpretation of question 2, which is inconsistent with the teacher's schematization?

5.3 Student's point of view

We are now making hypotheses about the student's inferences in the interpretation of the exercise. The first interesting fact to notice, is that her numerical answer seems correct: She writes " $g=9,81N/kg$ ". Yet, this result does not match the calculation she proposes with " F/M ". If, according to her proposal, we replace m by the mass of the Moon, M by the mass of the Earth, r by the distance between the Moon and the Earth, the worth of g would be 0,00239 rather than 9,81. She probably simply skipped the calculation, writing the answer straight away.

The calculation is nevertheless not the main issue here. In order to check the plausibility of the hypothesis of a situation of misunderstanding, we need to reconstruct her reasoning. More specifically, the relevant question may be: Why has the student decided to find the value of g from the fall of the Moon onto the Earth? The hypothesis we will support here, is that the partly joined layout for question 1 and 2 has supported an inference from the student, in her interpretation of the task, that both questions were related.

Another element of the situation of interlocution may play a role in this interpretation. Since in Newtonian mechanics students are induced to treat object as *mathematical dots*, the decision they

should make here in the modeling of the fall of any object on Earth as to take the radius of the earth for r may appear contradictory to the habitual representation of objects as having no volume nor surface. Yet, it is of course only a limited understanding of the concept of mathematical dots and its use for modeling in Mechanics that is at stake, since it is precisely by modeling the Earth as a dot, topographically corresponding to its gravity center, that r can be conceived as the distance between the center (the position of the mathematical dot) and the surface of the Earth (where the fall of the object takes place).

5.4 Description of a situation of misunderstanding

The third step of the analysis consists in a precise description, with Natural Logic, of the discrepancies between the teacher's point of view on the problem and the student's point of view. We have made the hypothesis that the difference consists in a logico-discursive operation relating exercise 1 and exercise 2. In order to make hypotheses about the interpretation of question 1 and 2, it is necessary to first describe the questions with logico-discursive operations. The written verbal content on the exercise sheet can be described as three logico-discursive operations of *determination*⁴, and one operation of *configuration*, written below⁵.

⁴ In order to simplify the presentation, operations introducing object-class (α) and predicate (η) have not been written since the contribution of these operations to the schematization is visible through more complex operations (δ and τ).

⁵ The operations are denoted with Greek letters (e.g. δ), and subscript numbers have been added for further reference to each particular operation (symbolized by ' \Rightarrow '). Implicit parts of the discourse that needed to be mentioned are written in square brackets, e.g. [implicit discourse], and are limited to the strict minimum. The result of the operation (after the ' \Rightarrow ') are denoted with Latin letters (e.g. \mathbf{d}) and corresponding subscript. This notation allows to distinguish between the process of transformation of the discourse (operations) and the result of it (products), which are specific part of the schematization (*objects of discourse, decisions, configurations, etc.*). Grize (1996) clearly distinguishes the 'détermination' from the concept of 'proposition' in any propositional logic, which is abstracted from any content. Since he conceived his logic as a logic of action, we have decided to translate his French term 'détermination' with the

Question 1

- $\delta_1 \pm$ to calculate, {attraction force exerted by the Moon on the Earth} \Rightarrow (- to calculate the attraction force exerted by the Moon on the Earth)
 - \mathbf{d}_1 : (- to calculate the attraction force exerted by the Moon on the Earth)

Question 2

- $\delta_2 \pm$ to abstract, {expression of g } \Rightarrow (- to abstract the expression of g)
 - \mathbf{d}_2 : (- that the expression of g to abstract)
- $\delta_3 \pm$ to calculate, {value [of g]} \Rightarrow (- to calculate the value [of g])
 - \mathbf{d}_3 : (- to calculate the value [of g])
- $\tau_1 (\mathbf{d}_2, \mathbf{d}_3) \Rightarrow \mathbf{d}_2$ -and $\rightarrow \mathbf{d}_3$
 - $\mathbf{t}_1 : \mathbf{d}_2$ -and $\rightarrow \mathbf{d}_3$

We cannot take for granted the inference of a relation between question 1 and question 2. Indeed, it is not uncommon in school context to deal with a list of exercises on the same sheet, which are not related one to another. The hypothesis of an implicit operation of configuration [$\tau_2 (\mathbf{d}_1, \mathbf{d}_2, \mathbf{d}_3) \Rightarrow \mathbf{d}_1$ -? $\rightarrow (\mathbf{d}_2$ -and $\rightarrow \mathbf{d}_3)$] consists in an inference in the interpretation of the task that may not be common to the student's point of view and to the teacher's point of view. Moreover, the quality of this configuration, written '?', is at least partially implicit and must be reconstructed from clues in the situation and context. In order to evaluate the plausibility of a divergence in the logico-discursive operations from the two points of view, we will attempt to formulate these operations from both points of view before comparing them.

From the teacher's point of view, there is a relation between question 1 and question 2. The clues for supporting this reconstruction are not only the presence of the two questions on the same sheet, which in itself is insufficient, but the common theoretical presentation of the universal law of gravitation, and

term 'decision', which allows to read the conventional notation (- that ...) as 'a decision that ...' or (- to ...) as 'a decision to ...', where the dash ('-') stands for the action of determining the value of the predicate (or leaving it open in a question), e.g. \pm calculate, and of its association with the object-class, e.g. {attraction force exerted by the Moon on the Earth}.

the fact the astronomical data necessary for answering questions 1 are placed after question 2, on the page layout. In reference to Physics, it is expected for students to use some of the astronomical data for both questions, and that the universal gravitational law is used as a common reference for both questions. Moreover, the (partly) implicit operation τ from the teacher's point of view we are trying to hypothesize is (partly) verbalized with the title "applications". Rather than a direct implicit operation τ between \mathbf{d}_1 and \mathbf{d}_3 , we propose to describe two implicit configurations which are analogical to each other. To express these implicit configurations, we have to state the determining operation written at the top of the page:

- \mathbf{d}_0 \pm to be, {modulus of the gravitational force F between two bodies of mass m and M separated by a distance r between the centers of gravity}, $\{F=GmM/r^2\} \Rightarrow$ (- that modulus of the gravitational force F between two bodies of mass m and M separated by a distance r between the centers of gravity be $F=GmM/r^2$)
 - \mathbf{d}_0 : (- that modulus of the gravitational force F between two bodies of mass m and M separated by a distance r between the centers of gravity be $F=GmM/r^2$)

The two partially implicit configurations can be described:

- $\tau_2(\mathbf{d}_1, \mathbf{d}_2, \mathbf{d}_3) \Rightarrow \mathbf{d}_0$ -application $\rightarrow \mathbf{d}_1$
 - $\mathbf{t}_2 : \mathbf{d}_0$ -application $\rightarrow \mathbf{d}_1$
- $\tau_3(\mathbf{d}_1, \mathbf{d}_2, \mathbf{d}_3) \Rightarrow \mathbf{d}_0$ -application $\rightarrow (\mathbf{d}_2$ -and $\rightarrow \mathbf{d}_3)$
 - $\mathbf{t}_3 : \mathbf{d}_0$ -application $\rightarrow (\mathbf{d}_2$ -and $\rightarrow \mathbf{d}_3)$

This stated, the relation between question 1 and question 2 from the teacher's point of view can be described as an analogical operation with \mathbf{d}_0 . It is only analogical and not identical, because the actual use of \mathbf{d}_0 is different in both exercise. Yet, the logico-discursive operation -application \rightarrow is sufficiently vague to encompass both uses. It may be the that the student has not interpreted the concept the same way the teacher has, if she has at all read and interpreted the title "applications".

From the student's point of view, the relation between question 1 and 2 seems rather like a continuation. A clue of this hypothesis is that she uses her schematization to answer questions 1 as a

starting point to answer question 2. Moreover, she uses \mathbf{d}_0 identically in both answers, to express the force exerted by the Moon on the Earth (and vice-versa). The student's inference about the relation between question 1 and 2 remaining totally implicit, we only propose here a hypothesis based on the situational clues and the overall context. This hypothesis can be written:

$$[\tau_4 (\mathbf{d}_1, \mathbf{d}_2, \mathbf{d}_3) \Rightarrow \mathbf{d}_1 \text{ -[can be used for, ...]-} \rightarrow (\mathbf{d}_2 \text{ -and-} \rightarrow \mathbf{d}_3)]$$

This logico-discursive operation allows the student to skip the modeling phase for schematizing an answer to question 2. Instead of thinking of the Earth, the distance between the center of gravity and the surface in order to set a new value to r , the student starts with the same model of the attraction between the Moon and the Earth. Hence, it may be that the misunderstanding of τ_2 and τ_3 as τ_4 , is catalyzed by the lack of understanding, skill or practice of modeling. Despite writing « centers of gravity » on her exercise sheet (see Figure 5), the student has not understood this part of the schematization communicated by the teacher.

5.5 Synthesis

According to this analysis, the divergence between the teacher's point of view and the student's point of view, is not in an operation τ and its absence, but rather in the qualitative specificity of the configuration relating questions 1 and 2. For the teacher, there are two partly implicit analogical configurations $\mathbf{d}_0 \text{ -application-} \rightarrow \dots$, while for the student there is an operation between \mathbf{d}_1 and $(\mathbf{d}_2 \text{ -and-} \rightarrow \mathbf{d}_3)$, which remains totally implicit, and probably quite vague. In Natural Logic, operations of configuration are usually qualified with the actual discourse, in order notably to keep the ambiguity as it is stated. For instance, an operation '-and-' can take several meaning which often are quite far from the formal logic " \cap ". Grize (1996) provides example where '-and-' takes rather the meaning of a contiguity, a sequential suite. The partially undefined meaning, or vagueness of such operation is of particular interest for the analysis of situations of misunderstanding.

6. DISCUSSION

In this paper, we aimed to understand how students points of view may fail to match the points of view of their teachers or evaluators, focusing on possible situations of misunderstanding. Both our analyses provide evidence for supporting the hypothesis of a situation of misunderstanding in the examples provided. The first analysis leads to question the context in which the argumentation takes place, and notably stresses the lack of clues for the student's inference. More particularly, the student's point of view can be shown to simultaneously respond to various issues. A similar result emerges from the second analysis: while the relation between exercise 1 and 2 can be precisely described with a logico-discursive operation from the teacher's point of view, the analysis shows that the corresponding inference from the student's point of view is not only different, but also less precisely defined. In both analysis, the situation of misunderstanding is elicited with discrepancies in the inferences made for interpreting the tasks. Yet, the focus is slightly different. In the first analysis, the reconstruction of the two points of view focuses on the interpretation of the issue, while in the second analysis the reconstruction of the student's point of view guides the analysis towards inferences on a partially implicit relation between the various parts of the symbolic content of the exercise sheet, and about its layout. On one hand, the analytical approach based on the pragma-dialectical model allows to stress the specificities of the educational context, where the issue is confused by an asymmetrical relationship where the students has to show his or her skills rather than develop an argumentation of his own. Moreover, we can make the hypothesis that in such asymmetrical situations, typical of tests, the different stages of a critical discussion may be easily disrupted. Grize's logico-discursive operations, on the other hand, lead the focus towards semiotics, the peculiar use by one student of signs and the sheet's layout for drawing inferences about the meaning of the school task.

Although we are still working on this tentative to use analytical models as a mean to study the interpretation of school situations and the potential difficulties for children to answer to the school's requirements, we can already underline some interesting results from these first observations. Indeed, the first analysis raises the various possible inferences about the issue of the argumentation. The diversity of issues to be discussed about the chosen Pisa item is important, despite a highly-constrained and framed interlocutory situation, in the context of a cross-country comparison for which state-of-the-art technical knowledge has

been used in order to avoid any interpretative difficulties. The second analysis raises discrepancies in the inferences about the layout of the exercise sheet, which leads the student to engage in a cognitive activity far from the teacher's expectation.

Altogether, these observations contribute to show divergence in interpretations from different points of view on school tasks with a methodology of analysis based on explicit models which are providing a framework for making hypotheses about the particular interpretations of the agent involved in the situation and discussing it, while keeping the particular qualitative features of the discourse and situation under study.

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APPENDIX

ROBBERIES SCORING 1

[Note: The use of NO in these codes includes all statements indicating that the interpretation of the graph is NOT reasonable. YES includes all statements indicating that the interpretation is reasonable. Please assess whether the student's response indicates that the interpretation of the graph is reasonable or not reasonable, and do not simply take the words "YES" or "NO" as criteria for codes.]

Full Credit

Code 21: No, not reasonable. Focuses on the fact that only a **small part** of the graph is shown.

- Not reasonable. The entire graph should be displayed.
- I don't think it is a reasonable interpretation of the graph because if they were to show the whole graph you would see that there is only a slight increase in robberies.
- No, because he has used the top bit of the graph and if you looked at the whole graph from 0 – 520, it wouldn't have risen so much.
- No, because the graph makes it look like there's been a big increase but you look at the numbers and there's not much of an increase.

Code 22: No, not reasonable. Contains correct arguments in terms of ratio or

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percentage increase.

- No, not reasonable. 10 is not a huge increase compared to a total of 500.
- No, not reasonable. According to the percentage, the increase is only about 2%.
- No. 8 more robberies is 1.5% increase. Not much in my opinion!
- No, only 8 or 9 more for this year. Compared to 507, it is not a large number.

Code 23: Trend data is required before a judgement can be made.

- We can't tell whether the increase is huge or not. If in 1997, the number of robberies is the same as in 1998, then we could say there is a huge increase in 1999.
- There is no way of knowing what "huge" is because you need at least two changes to think one huge and one small.

Partial Credit

Code 11: No, not reasonable, but explanation lacks detail.

- Focuses ONLY on an increase given by the exact number of robberies, but does not compare with the total.
- Not reasonable. It increased by about 10 robberies. The word "huge" does not explain the reality of the increased number of robberies. The increase was only about 10 and I wouldn't call that "huge".
- From 508 to 515 is not a large increase.
- No, because 8 or 9 is not a large amount.
- Sort of. From 507 to 515 is an increase, but not huge.

[Note that as the scale on the graph is not that clear, accept between 5 and 15 for the increase of the exact number of robberies.]

Code 12: No, not reasonable, with correct method but with minor computational errors.

- Correct method and conclusion but the percentage calculated is 0.03%.

Figure 8 – Scoring sheet for the item “Robberies”, part I (PISA, OECD).

No Credit

Code 01: No, with no, insufficient or incorrect explanation.

- No, I don't agree.
- The reporter should not have used the word "huge".
- No, it's not reasonable. Reporters always like to exaggerate.

Code 02: Yes, focuses on the appearance of the graph and mentions that the number of robberies doubled.

- Yes, the graph doubles its height.
- Yes, the number of robberies has almost doubled.

Code 03: Yes, with no explanation, or explanations other than Code 02.

Code 04: Other responses.

Code 99: Missing.

Figure 9 – Scoring sheet for the item “Robberies”, part II (PISA, OECD).