

5. ANALYSING TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE FROM THE PERSPECTIVE OF THE JOINT ACTION THEORY IN DIDACTICS

In this paper, I argue that teachers' pedagogical content knowledge needs to be acknowledged and analysed through an accurate system of description. Such a system can be seen as a generic system of strategies that a teacher is able to manage and to specify to the knowledge at stake. That is to say that, in order to provide such a description, one has to inquire into the nature of the didactic activity, and delineate its theoretical structure as a theory of practice (Bourdieu, 1990). A teacher's pedagogical content knowledge may be considered as a "practical sense", a "feel for the game" (Bourdieu, 1990a, 1990b) in which the teacher embodies this theory.

In this contribution, I first describe a theoretical framework that one may use as a theory of didactic practice, the joint action theory in didactics (Sensevy, 2012, 2014; Ligozat, 2011; Tiberghien & Malkoun, 2009; Venturini & Amade-Escot, 2013). Within this framework, 'didactic' means 'which refers to the teaching-learning process'. Then I focus on the structure and dynamics of the teacher's pedagogical content knowledge, as it can be understood through this theory. I propose to analyse and explore the teacher's strategic system by using the notion of counterfactual strategies, and to acknowledge and describe the teacher's pedagogical content knowledge as a practical awareness of a counterfactual system attached to a given practice, that one may conceptualise according to the categories of the theory. Such a counterfactual system is first described based on a system of previously exposed theoretical categories. It is then concretely used through an example I consider as emblematic. In the last part of the paper, I provide some elements of synthesis and discuss some issues related to this way of analysing the teacher's pedagogical content knowledge.

DESCRIBING THE TEACHER'S ACTION

In this part, I present the main elements of a theoretical framework – the Joint Action Theory in Didactics – that one may consider as a way of building dynamic "thick" descriptors (Ryle, 2009) of the teachers and students' knowledge-based joint activity. Particularly, I focus on a system of notions that may provide such descriptors: the didactic game, which depicts the teaching-learning activity as a teacher's game on the student's game, and reciprocally; the dialectics of telling-showing (expression)

and being tacit-hiding (reticence); the dialectics of what is previously known (the contract) and what is to be known through the problem to solve (the milieu); the entanglement of these two dialectics; the genesis triplet (which refers to the way knowledge is concretely processed through the teacher-student transactions).

The Didactic Activity and the Model of the Game

I argue that it is fruitful to consider the teacher and student's action as a joint game. This first means that we include this action in the general paradigm of joint action (Mead, 1967; Bruner, 1977, 1983; Clark, 1996; Eilan et al., 2005; Sebanz et al., 2006, Tomasello, 2014; Csibra & Gergely, 2011), in which human development and praxis are ontologically thought of as a joint activity. In order to describe this activity, one may use the concept of game to account for the way the social world is continuously constructed and perceived (Bourdieu, 1990a, 1990b; Elias, 2012; Bruner, 1983; Goffman, 1970; Wittgenstein, 1997). Through the concept of game, it is possible to see joint action as a particular kind of cooperative game in which players share a common goal.

One may include within this general paradigm the teacher and student's action, which we describe as a didactic game. In this game, the teacher wins if and only if the student wins, i.e. becomes capable of a particular behaviour that is recognised by the teacher as the right one. This simple description helps understand some of the fundamental features of the didactic activity. In this activity, the teacher's action success is determined by the student's behaviour, but the teacher is the one who acknowledges this behaviour as relevant. Namely, the teacher plays a very complex normative game on the student's game.

On the basis of this model, one may infer some prominent characteristics of joint didactic action that we would like to highlight in this paper.

The Reticence-Expression Dialectics

First, this model entails that the teacher does not tell the student in a direct way what kind of behaviour she has to be capable of. The student's behaviour has to be enacted by the student on her own, not as a kind of mimetic gesture, but as a comprehensive activity, which ensures the teacher that the student will be able to act accurately in an autonomous way. Accordingly, the teacher has to hide some meanings, she has to be tacit about some of the components of the piece of knowledge she is trying to teach. At the same time, she has to directly show some meanings, she has to be explicit about some other components of this piece of knowledge. We call this fundamental characteristic of the didactic action the reticence-expression dialectics. When a teacher teaches, she has to be reticent (to be tacit, to hide) about some meanings, and has to express (to make explicit, to show) other ones. This behavioural structure is a dialectical one in that reticence and expression are opposite and complementary. Indeed, as we will see below, it is possible to show that being reticent about a meaning

implies making explicit some related meanings, and reciprocally. This dialectical peculiarity is related both to the nature of language through its relation to reference (Quine, 1960) and to the very nature of the didactic communication.

The Milieu-Contract Dialectics

In order to learn, a student has to solve a problem, with this term being employed in a very general meaning. The student enters this problem through a specific state of knowledge related to the problem. In a didactic setting, this state of knowledge can be analysed as the 'previously known' about the piece of knowledge at stake.

It is worth noticing the specificity of this knowledge, which is the fruit of the previous didactic action. In that way, one may contend that the student's state of knowledge has been shaped within the previous didactic joint action. Following the didactic tradition (Brousseau, 1997), we term this previous knowledge system "didactic contract". The didactic contract can be seen as a system of meanings that one may analyse according to different descriptions. Each meaning of the didactic contract can at the same time be seen as a norm, a rule, a habit, a capacity, and an attribution of expectation. For example, when a student solves an arithmetical word problem he tries to find the 'good' arithmetical operation needed to solve the problem. The 'finding the good operation' part may be described at the same time as a norm, a rule of action, a habit, a capacity, an attribution of expectation (from the student to the teacher). As a 'previously known' piece of knowledge, shaped in the previous didactic joint activity between the teacher and the student, it belongs to the didactic contract, to the common background knowledge the students are able to use to solve the problem at stake.

This problem can be considered as a set of meanings (think, for example, of a word problem, or a text that has to be understood, or a picture that has to be interpreted), which puzzles the student. In its more general meaning, problem-solving, i.e., inquiry, can be seen as the search for a way of uniting within a meaningful whole various components of a situation that are not related together (Dewey, 1938).¹ One may say that the student has to transform a *set* of meanings in a *system* of meanings in the meaning-making process by achieving a unified whole. What we call milieu can be seen as a set of meanings that the student has to unify in order to solve the problem. In a nutshell, we can define the milieu as the symbolic structure of the problem the student (and the teacher, in the joint didactic game) has to deal with.

The milieu and the contract have to be seen as the components of an essential relation. When a student tries to solve a problem, he confronts a given symbolic structure (milieu) on the basis of previous background knowledge (contract). This relation is dialectical. Indeed, what has to be known (the milieu) is both the opposite of and complementary with the previously known (contract). It is complementary in that the new meaning cannot be apprehended without background knowledge that enables the student to orient herself through this new meaning. It is opposite, as the new is the opposite of the ancient.

The Entanglement of the Reticence-Expression Dialectics and the Milieu-Contract Dialectics in the Joint Didactic Game

As we have seen, we model the didactic activity as a joint game in which the teacher plays on the student’s game, and reciprocally. How is it possible to describe such a joint game? We argue that a primitive description of the didactic game can be enacted as follows. The teacher’s work consists of orienting the student’s work. She can do that in two different ways: 1) she can provide information about the previously known knowledge (contract); or 2) she can provide information about the nature of the symbolic structure of the problem which is to be solved (milieu). For example, she can tell the students “remember the last time we did such a problem” (acting on the previously known, i.e., acting on the contract) or “try to cautiously read the last sentence of the wording” (acting on the to be known, i.e., on the milieu). When providing such information, the teacher can be reticent (she can hide or be tacit on some meanings), or she can be expressive (she can show or be explicit on some meanings). More exactly, her utterances can be characterised through a certain amount of reticence, and a certain amount of expression. In our example above, the utterance “remember the last time we did this problem” is more reticent (less expressive) than “remember the last time we did a problem of subtraction”, and the utterance “try to cautiously read the last sentence of the wording” is more expressive (less reticent) than “try to read the wording”. Accordingly, the general structure of the joint didactic game (from the teacher’s viewpoint) can be presented in Table 1.

Table 1. The entanglement of the reticence-expression dialectics and the milieu-contract dialectics in the joint didactic game

Teacher’s action			
Teacher’s action on the students’ relationship to what is known (contract)		Teacher’s action on the students’ relationship to what is to be known (milieu)	
Reticence on what is known (contract reticence)	Expression of what is known (contract expression)	Reticence on what is to be known (milieu reticence)	Expression of what is to be known (milieu expression)

The Genesis Triplet

The last descriptor we present in this chapter is the genesis triplet, which refers to the way knowledge is concretely processed through the teacher-student transactions in the joint didactic game.

The first descriptor is topogenesis: the making (genesis) of the epistemic place in the game, relating to the knowledge at stake. A topogenetic analysis of a given didactic transaction consists of analysing what is the respective responsibility of the teacher

and the student toward the knowledge at stake. For example, when working out the solution to a problem the teacher can ask the students questions which contain the knowledge to be acquainted with, and the students have only to answer "yes" or "no". From a topogenetic viewpoint, we describe such a transaction as giving a prominent place to the teacher's relation to the knowledge, and an ancillary place to the student's relation to the knowledge. A good way to characterise this sharing of epistemic responsibility is to acknowledge that the teacher enacts thick epistemic utterances, which contain the heart of the subject matter to be known. On the other hand, we can think of the same kind of transactions within another division of epistemic labour in which the teacher asks only very general questions, or makes only some orienting remarks, while the students take a deep responsibility to work out the knowledge at stake. In this case, students will produce behaviours that one may recognise as thick epistemic utterances. Their topogenetic stance will be considered as a high one.

The second descriptor is chronogenesis: the making (genesis) of the knowledge time in the joint didactic game. A chronogenetic analysis of a given didactic transaction consists of analysing how the didactic time is moving forward. For example, one can think of a didactic literature activity in which the students need to identify who is the text's narrator in order to grasp some hidden meanings of the text. In analysing the didactic game, one may focus on the student's move (or teacher's move), which enables one to identify the narrator (i.e. to make the didactic time moving forward). Such moves will be termed chronogenetic moves in that they move the inquiry forward.

It is obvious that the two descriptors of topogenesis and chronogenesis are strongly related. For instance, a chronogenetic move, if it is acknowledged by the teacher, gives a high topogenetic stance to the student who has made his move. In this respect, the researcher may analyse the topogenetic structure of the chronogenesis by attempting to answer the question "Who is responsible for moving the didactic time forward?".

The third descriptor is mesogenesis: the making (genesis) of the milieu. Of course, this descriptor is strongly related to the contract-milieu dialectics. The goal of a mesogenetic description is to account for the way a set of unrelated meanings that the students have to deal with is transformed into a system of meanings that unify the initial symbolic structure of the problem they have encountered. One may say that this initial symbolic structure is a fuzzy one, whose various elements cannot be apprehended as a whole system resting on the knowledge at stake. The mesogenetic description makes understand dynamically how a united epistemic whole is to be achieved, to paraphrase John Dewey.

A good paradigmatic example of such a process can be found in the understanding process through a reading experience. The reader may confront a set of meanings she is able to understand one by one, but she does not succeed in identifying the general meaning of the text, which can be achieved by putting some of these 'primitive' meanings in a distinctive relationship, like a detective does when she fulfils an

inquiry grounded in a set of unrelated clues she is able to connect into a coherent whole, which gives her the solution to the enigma.

Of course, the genesis triplet (and not only the mesogenesis descriptor) may be related to the dialectics entanglement we have delineated above. We will see this in the following part.

PCK IN THE TEACHER’S ACTION

PCK as a System of Counterfactual Strategies Related to a Specific System of Knowledge

I argue that the teacher’s pedagogical content knowledge (TPCK) framework can be described against the background of the notions previously outlined.

In order to show this, I have to introduce the notion of counterfactual strategies. The term ‘counterfactual strategies’ can be seen as various virtual ways of acting that an analysis can propose as alternatives to a given actual practice.² The main end of using such a notion lies in enabling the researcher to focus on the concrete teaching-learning praxis, and to explore it, in order to bring about a kind of *ascent from the abstract to the concrete* (Marx, 2012; Kosik, 1976; Illenkov, 1982; Engeström, 2012).

Table 2 summarises our previous argumentation (CF holds for counterfactual).

Table 2. The entanglement of counterfactual strategies, contract and milieu

Known (contract)		To be known (milieu)		
CF Strategy 1	CF Strategy 2	CF Strategy 3	CF Strategy 4	CF Strategy 5
Strategy description				
Dialectical structure: known-to be known (mesogenesis)/ expression-reticence				
Topogenetic dynamics				
Chronogenetic dynamics				

In this perspective, TPCK can be seen as a particular system of skills specific to a given piece of knowledge, which relies on the repertoire of counterfactual strategies a certain teacher is able to envision relating to this system of knowledge, through the joint action she is involved in with the students. I argue that TPCK 'in action' is necessarily related to knowledge-related generic principles and strategic rules, but also needs to take into account the (more or less) contingent features of a situation nested in a given institution.

The entanglement of the two dialectics (contract-milieu and reticence-expression) of the joint didactic game, as I have described them above, is a kind of abstract formula that has to be grounded in concrete praxis in order to allow its exploration. This abstract formula is composed of *agentive* concepts which have a threefold function. First, the entangled dialectics enable the researcher (or the teacher) to account for the immanent logic of practice, its grammar; second, they allow the researcher (or the teacher) to envision other practical possibilities of the action, often by getting rid of "false necessities" (Unger, 2007) entrenched by an approximate or biased approach of practical activity; third, it provides the researcher (or the teacher) with a system of categories that may serve to describe and develop PCK.

PCK as a System of Counterfactual Strategies Related to a Specific System of Knowledge: An Example

In order to move the analysis work forward, I will focus on a practical exemplar which can be studied to both provide an emblem of the entanglement of dialectics I have presented and explore a possible structure of TPCK.

An analysis of a realised strategic system. I present a short episode in First Grade in Primary School in December, at a moment when the students ignore many phonemes and words. The session is starting.

The teacher has the students work on the following text (sentence)

Le père Noël va dans toutes les villes et villages. (Santa Claus is going in all the cities and villages).

The teacher is about to continue the collective reading of the text (by unveiling its second part on the board). He asks the students if someone knows something more in the text (the sentence)³ (see Table 3).

Table 3. An analysis of a realised strategic system in First Grade in Primary School

1. 10 min 20	Teacher	Does anybody know something more, maybe some little bits?
2.	Hugo	I know a little bit, me.
3.	T	Hugo?
4.	Hugo	“cadeau” (gift) Hugo goes to the board by saying “cadeau” (gift) while climbing up on the stool which enables students to work on the text directly (for example, by underlining some words).
5.	T	Wait! Before underlining, show us! <i>Hugo shows “villes” (cities) on the text that is put up on the central board.</i> You think that it is the word “cadeau” (gift)? Do you agree? <i>Hugo gets off the stool and waits in front of the board.</i>
<p>Hugo has made a mistake. He has read “cadeau” (gift) instead of “villes” (cities). P intervenes by asking Hugo to show “before underlining”. P knows that the word “cadeau” (gift) is not in the text. As Hugo goes to the board to underline the word (which would institutionalise the fact that the word is in the text), she asks him to show what he has ‘recognised’ as the word “cadeau” (gift) (which is actually the word “villes” (cities)). The teacher does not assess Hugo’s contention, and sends Hugo’s answer back to the class (SP 5. Do you agree?). We can see here a first bifurcation, from which other counterfactual strategies can be envisioned, as we will see. Hugo gets off the stool and is not in an ‘utterance position’.</p>		
6.	STs	No (<i>quite hesitating</i>)
<p>The students’ hesitant answer gives us a clue about the ‘knowledge state’ of the class. It seems that a certain number of students are in the same state as Hugo, i.e. a kind of uncertainty.</p>		
7.	T	Why Aude?
<p>P asks Aude, who expressed herself by raising her finger.</p>		
8.	Aude	Because there is “v” which changes. Because with the “P” it makes “vi” and then there are two “L”, it makes “ville” (city)
<p>Aude shows she is perfectly able to decipher the word.</p>		
9.	T	Look, Hugo! Lou, you are not with us. I write the word... <i>P is going to write the word “ville” on a board to the left of the one on which the text is stabled. At the same time as the teacher, Hugo moves himself to the board on the left.</i>
<p>P intervenes. In the same gesture: i) she ignores Aude’s production in a specific move we could term <i>selective deafness</i>. This slows the transaction time down, which we analyse as a chronogenetic move; ii) she writes the word “ville” (city) down on the board to the left, close to the studied text. While doing that, she offers a new reading object to the class. The milieu, as the symbolic structure of the problem to be solved, is changed (a mesogenetic move). Hugo bodily follows the teacher and the institution of the new milieu on the left board.</p>		

ANALYSING TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE

10.	STs	Gift (<i>cadeau</i>)												
The fact that some students say “gift” (<i>cadeau</i>) shows us some kind of remaining uncertainty in the class.														
11.	T	...that Hugo wanted to underline and he thought it was ‘gift’ (<i>cadeau</i>)												
<p>By offering this new word (<i>ville</i> – city) to the students’ reading, T expresses herself more or less directly about the fact that the word (falsely) identified by Hugo is not “<i>cadeau</i>” (gift).</p> <p>The strategy that T manages in the Speech Turn 9-11 thus consists of:</p> <ul style="list-style-type: none"> - staying reticent relating to the word «<i>ville</i>» (<i>cadeau</i>), that she does not read to the students, but that she gives as an object of study, by writing it down on the board; - expressing herself by creating an auxiliary milieu (writing the word “<i>ville</i>” down on the board), intended to build a relationship between the word written in the text (<i>ville</i>), that she copies on the board to the left, and the word “<i>cadeau</i>” (gift); and - relaxing the reticence on the word «<i>cadeau</i>» (gift) that she ‘disqualifies’ indirectly (ST 11: “and he thought it was ‘gift’ (<i>cadeau</i>)”), yet without emphasising this ‘disqualification’ in the didactic work. 														
<p>This is an example of the dialectics of reticence-expression since, while keeping the reticence on the crucial knowledge at stake (the reading of the word “<i>ville</i>” (city)), P expresses herself by building an auxiliary milieu (the students face the text (the board on the right) and the word “<i>ville</i>” (the board on the left)). The building of this auxiliary milieu (that one can see as a study milieu of the main milieu) enables the reticence on “<i>ville</i>” (city), reticence that can be relaxed on “gift” (<i>cadeau</i>). From the viewpoint of the respective share taken by the agents in the transaction (topogenesis), such a strategy appears as an incentive to the agency of the students who will have to scrutinise this auxiliary milieu in order to move forward.</p>														
12.	Aude	Ville (city)												
Aude confirms her knowing.														
13.	I	And well, we know the first letter. <i>T writes down the word “vélo” (bike) in a column under the word “ville” (city).</i>												
<p>Aude’s emphasis continues to be ignored by the teacher, who uses of the same ‘selective deafness’ I previously described. P continues to build the auxiliary milieu, which takes the form of an analogical comparison between the unknown word (<i>ville</i>) and another word (<i>vélo</i>). It is interesting to note that the teacher indirectly reminds the students that they know the word “<i>vélo</i>” (ST 1: And well, we know the first letter), which belongs to a class reference. Here is a representation of the board status.</p>														
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20px; text-align: center;">v</td> <td style="width: 20px; text-align: center;">i</td> <td style="width: 20px; text-align: center;">L</td> <td style="width: 20px; text-align: center;">l</td> <td style="width: 20px; text-align: center;">e</td> <td style="padding-left: 10px;">Unknown word, being worked on</td> </tr> <tr> <td style="text-align: center;">v</td> <td style="text-align: center;">é</td> <td style="text-align: center;">L</td> <td style="text-align: center;">o</td> <td></td> <td style="padding-left: 10px;">Known word, reference</td> </tr> </table>			v	i	L	l	e	Unknown word, being worked on	v	é	L	o		Known word, reference
v	i	L	l	e	Unknown word, being worked on									
v	é	L	o		Known word, reference									
14.	Sts	It’s “city” (<i>ville</i>)												
Some students have deciphered the unknown word (and/or they have heard Aude).														

(Continued)

15.	T	Wait! (T <i>laughs</i>).
T practices a light form of ‘selective deafness’ since she does not confirm that the word written on the board is “ <i>ville</i> ”, relating to those students who have already deciphered the word. She thus continues to slow the didactic pace down (a chronogenetic move).		
16.	Sts	Bike (<i>vélo</i>)
Some students have recognised « <i>vélo</i> » (bike)		
17.	T	This one, we know it.
The recognising of “ <i>vélo</i> ” (bike) is confirmed by the teacher, who does not read it aloud yet. A micro counterfactual strategy could have been “yes, it is ‘bike’”. In the class, the certainty state is strong about this word as shown by the students’ agreement in the next ST (18) and the teacher’s reaction (19).		
18.	Sts	Yes
19.	T	It is one of the first words we have learnt. What is the same in the word, in this one (<i>pointing to “ville”</i>) and in the second word (<i>pointing to “vélo”</i>)? T addresses both Hugo, who remains beside the board, and the whole class.
<p>P confirms anew the class’ ‘already-there’ knowledge about the word “<i>vélo</i>” (ST 19: It is one of the first words we have learnt), without uttering the word “<i>vélo</i>”. This is a ‘contract reminder’ move in which T reminds the students of the ‘old’ knowledge. Such a move is crucial to ensure that the students can engage in the work on the auxiliary milieu that is constituted by the ‘two words’ table. This move can be described as a micro-example emblematic of the expression-reticence dialectics on the already-there (contract). T expresses herself (ST 19: It is one of the first words we have learnt), while remaining reticent on this word (she does not say that it is “<i>vélo</i>” (bike)).</p> <p>In doing that, she gives the student the epistemic responsibility of a recognition effort. While saying “It is one of the first words we have learnt”, T organises the comparison (ST 19, What is the same in the word?), without specifying it, in order to trigger the deciphering of the word “<i>ville</i>” (city).</p> <p>The teacher’s management of the two words table (<i>ville/vélo</i>) may be described within the dialectics known (contract)-to be known (milieu) since the analogical orientation through the table (the identification of a meaningful relationship in the milieu) depends on the already-there knowledge of the word “<i>vélo</i>” (that one can see as a background meaning of the contract). This known (contract)-to be known (milieu) dialectics is entangled with the reticence-expression dialectics because the teacher expresses herself in the building of the analogical milieu (the table that I called “auxiliary milieu”), relaxes the reticence on the word “<i>vélo</i>” (bike), maintains the reticence on the word “<i>ville</i>” (city). The expression-reticence dialectics may also be understood at a finer scale of analysis. Indeed, when the teacher organises the comparison (ST 19, What is the same in the word?), she expresses herself (her utterance could be paraphrased as “compare the two words!”), but this expression makes (didactic) sense only through the reticence it implies at the same time (the reticence could have been relaxed, for example, by asking the students to compare the two words letter by letter (e.g., the teacher could have told them: “look at the first letter of each word, what can we say?”)).</p>		

ANALYSING TEACHERS' PEDAGOGICAL CONTENT KNOWLEDGE

<p>It is worth noticing that T, from the beginning of the session, includes Hugo in the transactions, even though he does not speak publicly. Hugo holds a 'special place' since he proposed the word "cadeau" and occupies a particular proxemic position in the classroom (beside the board and close to the teacher), while being 'one among others' in the "trilogue"²⁴ of the class.</p>		
20.	Sts	The V
21.	Sts	The first letter
<p>The students perform the correct analogy (the "v" of "ville" matches the "v" of "vélo").</p>		
22.	Hugo	<i>Hugo, from his position beside the board, raised his hand to ask for the floor for a while, and speaks without T's invitation. There is a V and an L in both words.</i>
<p>The fact that Hugo, as he is beside the board, raises his hand to ask for the floor is emblematic of his status of 'one among others' in the class. Even though the whole studied episode has its roots in the management of his error, Hugo has not played any specific role in this management until now. The teacher's work consisted of organising the collective study of one particular student's mistake.</p>		
23.	S	Well, right! This letter, how is it called? <i>T addresses Hugo.</i>
<p>As time goes by, Hugo does the analogical and deciphering work for himself. Thus P gives him the floor. In doing that, she enables him to tell the class what he has understood by asking him a question (This letter, how is it called?). Here, one can grasp the impact of the didactic time on the teacher's strategies. Some seconds before, the expression-reticence index would have been truly different. It is because the epistemic state of the class (as has been inferred from the teacher) – and consequently of Hugo too – has evolved and because the distance between the knowledge to be built and this epistemic state has been reduced, that the question can be asked in a fruitful way.</p>		
24.	Hugo	<i>Vé (the first letter of "ville" is "v", which is pronounced "vé")</i>
25.	T	And when it sings, what does it make? <i>P addresses the whole class and Hugo</i>
<p>T 'gathers' the class as a whole, including Hugo, by checking/strengthening the 'already-there' knowledge (the phoneme "V").</p>		
26.	Stds	Vvvvvvvvvv....
27.	P	<i>I am going to circle another little word, and I am sure that you can read it (to Hugo). What is it? T circles together the two letters "i" and "l" in the word "ville", thereby making the word "il", which means "he" in French, and which is already known in the class.</i>

(Continued)

<p>P relies on already-there knowledge (the pronoun “<i>il</i>” (he) which belongs to the repertoire of words in the class). The semiotic system the teacher produces (while circling the word “<i>il</i>” in the word “<i>ville</i>”, in ST 27) enables the students to distinguish the known in the less known (“<i>il</i>” in “<i>ville</i>”) and the teacher to organise the deciphering process. In addition to this semiotic system, T utters an assertion whose effects may be thought of as both epistemic and affective (TST 27: “I am sure that you can read it”). We raise the hypothesis that this assertion enables Hugo to gain confidence, a kind of confidence that is both epistemic (Hugo knows that he knows) and affective (Hugo is recognised as capable of participating fruitfully in the classroom work). From the strategic viewpoint we are trying to delineate in this chapter, one may notice the dialectical relationship in the teacher’s move. The teacher’s form of expression (the circling of the word-syllable “<i>il</i>” (he)) may be described as a form of reticence. For example, T could have directly shown Hugo a poster in the classroom on which “<i>il</i>” (he) is present. In this example, one may find a very general dialectical feature of the didactic relationship: when a teacher expresses something, she is reticent about some other things related to the one she is expressing. In a way, to say or show something means to be tacit about or to hide a lot of things that could have been said or shown⁵.</p>		
28.	Hugo	«Il»
<p>The pronoun “he” is recognised by Hugo.</p>		
29.	T	And what does it make?
<p>T encourages Hugo to make the synthesis «v» + «il». Here one may again see how T’s expression (St 29) could be both less direct and more reticent (she could stay silent conspicuously or wait), or more direct and less reticent (for example, she might connect on the board with the ruler or her finger the “v” and the “<i>il</i>”).</p>		
30.	Hugo	Ville
31.	Sts + Hugo	It makes “ <i>ville</i> ”
<p>Hugo, then Hugo and some students, decipher “<i>ville</i>” correctly. One may note that during the last part of the comparison, in which Hugo played the ‘first role’, the class continued to be present, and systematically called upon by the teacher, in a trilogy with Hugo. One may speak now of a ‘concertante’ didactic form in which the solo instrument production (Hugo) is accompanied by the orchestra (the class), with ‘the solo instrument’ remaining silent for most of the episode.</p>		
32.	T	So we have found it, but we cannot read it. Therefore, in what colour are we going to underline it?
<p>Here, the teacher enacts a class habit, which consists of underlining in red the words that the class ‘cannot read’ (whose knowledge has not yet been institutionalised). Even though it is eventually read correctly, “<i>Ville</i>” will be underlined in red to emphasise its novelty.</p>		

In the preceding analysis, I tried to produce a description of action that is closest to the meaning of action for the agents (the teacher and students). Where possible, I attempted to use some agentive concepts (reticence, expression, contract (‘already known’), milieu (‘structure of the to be known’), the genesis triplet), which can

provide a kind of paraphrasing of the action in which – as we hypothesise – the agents might recognise themselves.

This description leads to the building of a realised strategic system, an actual strategic system that one may describe as follows at a (relatively) large scale of description.

The teacher, encountering the mistake of a student, Hugo, who confuses “*ville*” (city) and “*cadeau*” (gift), treats this mistake in a collective way. Without taking Aude’s oral production into account, given this student knows the right answer, she has the class decipher the word “*ville*” without focusing on the word “*cadeau*”. To do that, she has the class compare the unknown word “*ville*” to the word “*vélo*” (bike), which is a known word, belonging to the already-there repertoire. At the end of this comparison, the teacher focuses on Hugo’s behaviour, and Hugo takes on the leading role to elucidate the word “*ville*”, always in cooperation with the whole class. The teacher helps her achieve this elucidation by orienting the student’s attention to the “little word” “*il*” (he), which belongs to the class repertoire.

This action summary can be made denser if one notes that the teacher continuously played with the expression-reticence dialectics, for example by building the “*ville*”-“*vélo*” table for the students, and by asking the class to study it. In this case, this expression-reticence dialectics is entangled with the already known–to be known dialectics, which grounds the grasping of the unknown (*ville*) on taking the known (*vélo*) into account.

We also saw that the teacher slowed the didactic pace down (a chronogenetic move), notably by employing the selective deafness with which she treats Aude’s good answer, while giving the students a distinct topogenetic position, a relatively high one, that one could see as an average position. According to us, it is fundamental to understand that this kind of topogenetic position is a consequence of the game played by the teacher on the students’ game, i.e., a consequence of the specific entanglement of the two dialectics (expression-reticence and contract-milieu) that we have described in the teacher’s action.

This strategic system may be both guaranteed and refined by taking the teacher’s discourse on her practice⁶ into account: first, through her reaction to the analysis provided; then by the information that she may offer on what has been going on from her first-person viewpoint; and more generally on some sources of her action. For example, among them, an element of the ‘didactic biography’ of the class refers to the fact that Hugo is considered by the teacher as a capable student, but a ‘very young one’. Another point is that Hugo’s production can be seen as a good indicator of the average level of the class.

But one may contend that it is possible to go further in the practical study of this action by counterfactually reflecting on what it could have been, not only with another teacher in some slightly different circumstances (for example, slightly earlier or later in the year), but by the same teacher whose activity would have been oriented through other branchings of practice.

Analysis of other counterfactual strategic systems. One may distinguish four strategic systems in the counterfactual analysis of this episode, with the fifth being the actual strategic system.⁷

This conceptualisation rests, as I contend below, on practice bifurcations (branchings), but it is partially arbitrary. Its purpose is not ‘to say’ what could have occurred but, while imagining other possibilities to achieve a better understanding of the stratification of action by achieving a better understanding of how the actual has unfolded close to, even against, some other possible options.

- Counterfactual strategic system 1

T estimates that the epistemic state is sufficient to allow the error’s immediate rectification. She thus corrects Hugo’s mistake by relying on what he thinks of as already-there knowledge (for example, the fact that there is a letter and a phoneme “i” in “ville”, and a letter and a phoneme “a” in “cadeau”). For instance, she tells directly Hugo and the class: “it’s not ‘cadeau’, one may hear ‘a’ at the beginning of ‘cadeau’, and there is no the letter ‘a’ in ‘ville’”.

In this counterfactual, T therefore relies on the known, the already-there, the didactic contract, to which she attributes some properties that enable the students to follow her reasoning. Her expression encompasses little reticence since she thinks that there are a few things to discover.

From a topogenetic viewpoint, the teacher’s position is very high (she brings the major part of knowledge), the students’ one is very low (they only have to follow the teacher’s explanation).

The chronogenetic pace is very rapid. Little study time is given to the students to appropriate the teacher’s discourse because she postulates a short epistemic distance between the students’ state and what is asked to them.

- Counterfactual strategic system 2

In this strategy, T facilitates exploration of the word “ville”. For that, she directly asks the students the first letter of the sought word. This expression consists of organising the exploration of the unknown word, a little bit as in the realised strategy, and thus relies, contrary to the first counterfactual above, on a certain amount of reticence justified by the exploration of what is to be known. However, by comparison with the realised strategy, this exploration takes the form of a ‘questioning process’ that may directly bring the students to the known.

From a topogenetic viewpoint, the teacher’s position is high in that she assumes the responsibility to focus the students’ attention on the first letter, but the topogenesis is more equally shared than in the previous counterfactual since the students are given the responsibility to search for the initial letter by themselves, and not only to ‘record’ their teacher’s reasoning.

The students’ inquiry slows the chronogenetic pace down (by comparison with the previous counterfactual), even though one may think that in this counterfactual strategy the students do not remain in an inquiry stance for a long time.

- Counterfactual strategic system 4

In this strategy, T manages the students' action by focusing their attention on the unknown. For example, she writes the word "*cadeau*" on the board, and asks the students to study it (what makes this strategy reasonable is that the letter "a" is known by the students, and thus is a solid known point in the unknown). It is a refutation strategy in which the teacher expects the students to produce on their own the reasoning that she produces in the first counterfactual above. The teacher's expression contains the reticence of this reasoning (she simply writes the word down on the board by asking students to study it, without giving any rationale).

From a topogenetic viewpoint, the students gain an amount of responsibility relating to the preceding counterfactual because the production of the refuting reasoning lies in their responsibility.

From a chronogenetic viewpoint, this strategy entails an opening of the didactic time, with a certain amount of study time being given to the students to work out the word "*cadeau*" and invalidate it as the meaning of "*ville*".

- Counterfactual strategic system 5

The (arbitrarily) last counterfactual strategy may consist of thinking that the students can refute by themselves the production of "*cadeau*" and/or read "*ville*". In this counterfactual, the teacher symbolically abandons the didactic stage, for example by saying: "Well, Hugo says that this word (while indicating "*cadeau*") is the word '*ville*'. What do you think of that?". In so doing, the teacher holds on strong reticence both on the known (she does not refer to any word of the class repertoire which might facilitate their inquiry) and the to be known, that she does not seek to relate to the known, which she does not even attempt to structure.

From a topogenetic viewpoint, the epistemic part taken on by the students may become very important.

The chronogenetic pace inherent to this strategy slows the didactic time down.

- The actual strategic system

The counterfactual strategic systems I described above enable a better understanding, in contrast, of the very structure and dynamics of the actually produced strategic system. One may contend that this strategic system holds a specific equilibrium, from the point of view of the entanglement of the dialectics known-to be known/expression-reticence, from the topogenetic viewpoint (the didactic responsibilities are shared by the teacher and the students), and from the chronogenetic viewpoint (the didactic pace depends on some selective deafness regarding some students' production, some slowing down, some acceleration).

The whole set of the studied counterfactual strategies is gathered in the following synoptic table as a kind of synthesis (CF stands for counterfactual, Top for topogenetic, C for chronogenetic, T for teacher, S for student).

Table 4. The whole set of the studied counterfactual strategies

Known (contract)			To be known (milieu)	
CF strategy 1	CF strategy 2	Actual strategy 3	CF strategy 4	CF strategy 5
Saying directly: “not <i>cadeau</i> , <i>ville</i> ”	Asking students the first letter of the word « <i>ville</i> »	Producing the « <i>ville-vélo</i> » table	Writing « <i>Cadeau</i> » on the board	Letting the students reflect on the text
Immediate recognising of the known (contract)	Recognising of the known (contract)	Working out specifically the relationship known-to be known (contract-milieu)	Exploring the to be known (milieu) by relying on the known	‘Free’ exploration of the to be known (milieu)
Expression with minimum reticence	Expression with little reticence	Expression with significant reticence	Expression with major reticence	Reticence with minimum expression
Top T >> S	Top T > S	Top P = S	Top T < S	Top T << S
Chron pace ++	Chron pace +	Chron pace =	Chron pace -	Chron pace --

SOME CRUCIAL DIMENSIONS OF TEACHERS’ PEDAGOGICAL CONTENT KNOWLEDGE

The previous analysis provides us with a theoretical framework that can be used as a way of characterising teachers’ pedagogical content knowledge. In such a perspective, TPCK can be seen as a particular system of skills specific to a given piece of knowledge, which encompasses the repertoire of counterfactual strategies that a given teacher is able to concretely envision relating to this system of knowledge, through the joint action she is involved in with the students.

In that way, we see TPCK as a specific system of knowledge related to a counterfactual strategies system. It is worth delineating the nature of this system of knowledge and counterfactual strategies that we see as a core feature of TPCK. I would like to emphasise the following points.

The Nature of the Counterfactual System in TPCK

The counterfactual strategies system of knowledge refers to the teacher and students’ joint action. It follows the fundamental argumentation according to which the teaching-learning activity (the didactic action) may be modelled as a teacher’s game on the students’ game. But the structure of this game, its grammar, needs to be recognised as such. I have determined two core dialectics of the didactic action which stem from the very nature of this process. This action is an epistemic action (i.e. relating to the mastering of knowledge), which simply means that learning occurs from a current state of knowledge towards new knowledge that is appropriated

through the solving of a problem (in the more general sense of this term). Therefore, the teacher's game on the students' game has to take account of the relationship between the ancient knowledge, that has been dynamically built in the classroom transactions (the contract), and the knowledge to be acquired, that is symbolically embedded in the problem to be solved (the milieu). In the studied example, which I consider as emblematic, it is easy to note that the teacher's game rests on very good knowledge of what the students know (contract), and how a symbolic structure (a milieu) may be built to organise the emergence of new knowledge from the ancient one (for example, the *ville-vélo* table). I argue that the deep knowledge of the students' 'current epistemic state' – the contract knowledge – is a fundamental point of departure of any didactic action, and therefore a foundation of the TPCK. In a similar way, I contend that the way the teacher is able to design a milieu that embeds the knowledge at stake, while taking the current epistemic state of the students relating to this knowledge into account, is another foundation of the PCK. It is worth noticing that this part of the teacher and students' joint action, as a designing process, is essentially a priori. It is fundamentally a joint action in that the teacher's action may be thought of as transactional work in which the current students' epistemic state and the 'target' students' epistemic state are the touchstones of the designing process. In our studied episode, for example, the teacher's use of the *ville-vélo* table does not come from nowhere. This kind of table belongs to the teacher's repertoire. Given this fact, the teaching problem consists of choosing the components of the table in the course of action, and in proposing it or not to the students.

I draw a hypothesis of a difference in nature between these two foundations of the TPCK (the contract knowledge, and the milieu design). The first one (contract knowledge) asks for a kind of lucidity, for the teacher, about the students' current epistemic state, which means both knowledge of the average epistemic state, and of the possible variations among students regarding this piece of knowledge. The second one (milieu design) opens up possibilities in that it supposes creating didactic situations, although it rests on the contract knowledge. It is a first locus in which counterfactual skills are necessary to the teaching process. Designing a milieu asks for taking into account the students' current epistemic state about the piece of knowledge at stake, the variation among the different individual epistemic states, the distance between this current epistemic state and this piece of knowledge. The milieu design rests on deep knowledge of the content at stake, which I am going to characterise with help of the notion of epistemic game.

What is Content in TPCK: The Notion of Epistemic Game as a Way of Modelling the Didactic Transposition

The counterfactual strategies system of knowledge relies on a specific relationship to the content at stake through the designing of the milieu. I argue that a core criterion of TPCK's apprehension and understanding may rest on the way the didactic practice is related to a fundamental knowledge practice that one may find

in culture. For example, when a teacher teaches writing, she may refer this teaching to a school practice (for example, a classic school composition in which a student relates her holiday), or to different cultural practices, for instance that of a journalist, an essayist, or a novelist. In this case, one of the main criteria of the quality of the didactic practice lies in the kind of ‘authenticity’ of this practice, not in the way the didactic practice tends to imitate the cultural practice (school practice and cultural practice are different), but in the way the didactic practice is nurtured by the teacher’s knowledge of the main features of the cultural practice it refers to. I argue that, in order to ensure a specific kind of relevance and authenticity to the teaching-learning practice, the teacher has to become a connoisseur of the cultural practice or reference, firstly by inquiring into the way it unfolds in real practice (for example, a journalist or novelist’s practice), and secondly by becoming acquainted with a model of this practice, that I term an epistemic game. In this respect, an epistemic game can be seen as an effort to accomplish the didactic transposition (Chevallard, 2007) in a manner that embeds the ‘substantive marrow’ of the cultural practice in the designed didactic practice.

In the reading example we studied in this chapter, one could say that it is not so simple to recognise to what cultural practice the teacher’s action can be related. At a first level, however, it is possible to acknowledge that this episode may be understood as a sample of a large process of entering into reading and writing practices, which shape Western culture as such (Goody, 1977). At a second level, the analysis of this episode shows how the teacher’s strategies enable the students to inquire into the nature of words by comparing them in a table (a table is a core feature of the writing culture, says Goody), in a specific topogenesis stance which enables the students to both encounter the ‘table pattern’ and inquire into what it displays.

I thus contend that the teacher’s work in this episode is nurtured by the cultural practice at two levels, even though the class session is carried out at the beginning of primary school for ‘elementary’ knowledge. The didactic practice is nurtured at an epistemic level in which the deciphering process is grounded in the taking into account of a comparison that the table organises. It is nurtured at an epistemological level that one may acknowledge in the way the deciphering practice is performed through an inquiry process that one may see as students’ familiarisation with a first kind of ‘hermeneutics’.

TPCK ‘in Action’

I argue that TPCK ‘in action’ is necessarily grounded on the knowledge-related generic system I tried to display above. This system may help model the teacher’s intentional stance, that one may see through a threefold structure (Sensevy, 2011, 2012, 2014), which encompasses distal intentions (the general intentional structure for teaching a piece of knowledge), proximal intentions (the specific intentional structure related to a given set of situations in which this piece of knowledge is taught), intentions in action (the intentional structure as it is directly shaped by

taking the situation feedback into account, the (more or less) contingent features of a situation related to this piece of knowledge). It is worth noticing that TPCK has to be described not only on the basis of distal and proximal intentions, but in the way the 'here and now' of practice orients the teacher's strategic action. For example, in the reading example I studied above, it is important to acknowledge that the teacher and students' joint action needs to be understood on the basis of a contingent fact (Hugo's proposal of "*cadeau*" (gift) in place of "*ville*" (city)) that one can see as a point of departure of the whole strategic system I described above. While managing Hugo's proposal, the teacher concretises an action that I have modelled through the theoretical framework that I describe in this chapter (notably the teacher's game on the students' game, the entanglement of the two dialectics contract-milieu and reticence-expression, the genesis triplet) but one has to keep in mind that this thick description (Ryle, 2009) rests on the initial fact that the teacher was able to monitor the behaviours of Hugo and the class within a certain kind of structured improvisation. This emphasises the way teachers' dispositions may be seen as theoretical categories in a practical state (Bourdieu, 1990a), as practical behaviours that express the logic of practice. In trying to acknowledge TPCK, the researcher has to both identify this logic of practice and produce a system of categories that may enable her to describe the feel for the game (Bourdieu, 1990a) that enables the teacher to relate her general (distal) and specific (proximal) intentions to her intentions in action in a concrete, coherent and effective whole.

OPENING UP THE DISCUSSION: A REPRESENTATION OF THE TPCK RELATING TO A GIVEN PIECE OF KNOWLEDGE

Figure 1 may be commented on as follows.

a) Arrow (0) refers to the way the problem related to a given piece of knowledge can be reflected through a connoisseur's practice, in the culture, and thus to the teacher's knowledge of this practice, that one may model as an epistemic game. In a way, this could be described by a question: "To what extent is the teacher a connoisseur's practice connoisseur?". For example, if he teaches literature, mathematics, dance, then to what extent is the teacher a connoisseur of the writer's practice, mathematician's practice, and dancer's practice. I would like to emphasise that the kind of knowledge I am referring to is the knowledge of a knowledge practice, not only of the content displayed in textbooks. That particularly means that the teacher has to be a connoisseur not only of the "knowing that" (Ryle, 2009) related to the piece of knowledge at stake, but also of the "knowing how" (Ryle, 2009) that fosters practical mastering. In particular, he has to be familiar with the epistemological system that characterises the knowledge practice of reference of his teaching. I thereby argue that the didactic transposition process (Chevallard, 2007) has to be thought of as the modelling of a given knowledge practice. I term this model an *epistemic game* in that this is an actional model ('game') which refers to knowledge ('epistemic'), and which is focused on some distinctive essential features

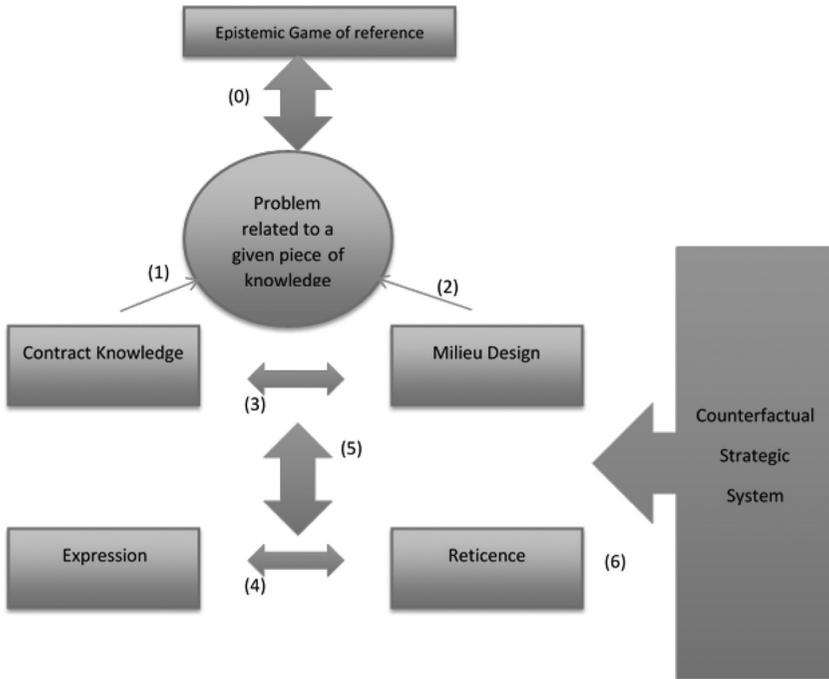


Figure 1. A representation of the TPCCK relating to a given piece of knowledge

of the knowledge practice as practical connoisseurs of this practice demonstrate them. It is these features that the authors of the model want to focus on in order to nurture the didactic practice.

b) Arrow (1) is related to the teacher’s awareness of the students’ current system of knowledge, the ‘already-there’ knowledge with which the students are going to cope with the problem. It is important to note that this system, as shaping the didactic contract, can be seen not only as a system of habits or expectations, but as a system of capacities, a strategic system. Arrow (1) therefore indicates the teacher’s oriented practical knowledge of the students’ strategic system. It refers to a kind of the teacher’s knowledge that one may describe as follows: ‘relating to the problem concerning this piece of knowledge, I anticipate that some students may be able to say S and to do D; in case they say S, I can act in this way..., in case they do D, I can act in this way...’. It is one of the main loci where counterfactual strategies may be thought of.

c) Arrow (2) characterises the designing process in which the teacher commits herself to the design of a milieu that gives a specific symbolic structure to the problem to be dealt with. Of course, this designing process has to take into account

the students' already-there knowledge (the contract), however this process unfolds before the class, or during it. It is a crucial part of the dialectics of contract and milieu that the teacher has to manage, and one of the fundamental features of the teacher's craft.

Arrow (3) symbolises the dialectics of contract and milieu that I delineated above. While teaching, the teacher has to rely on previous knowledge that she attributes to the students (contract), or to orient the students' activity to the symbolic structure of the problem (milieu).

e) Arrow (4) represents the dialectics of expression and reticence that I described above. While teaching the teacher speaks and/or moves, and while speaking and/or moving she expresses some meanings while being reticent on some other ones.

f) Arrow (5) designates what I term in this chapter the entanglement of the two dialectics previously described. One could describe a threefold equilibrium. The first one denotes the contract-milieu dialectics, when the equilibrium is built in teacher's practice between relying on the students' already-there knowledge, and orienting them in the symbolic structure of the milieu. The second equilibrium that the teacher enacts is a specific equilibrium between reticence (which meanings are concealed by the reticence process) and expression (which meanings are revealed by the expression process). The third equilibrium entangles the two first, which can be expressed as follows: the teacher's reticence can be focused on the contract or it can be focused on the milieu; the teacher's expression can be focused on the contract or it can be focused on the milieu.

g) Arrow (6) refers to the amount of variation the teacher is able to envision when confronting a teaching-learning issue.

NOTES

- ¹ Dewey defined inquiry as "the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole" (Dewey, 1938/2008, pp. 104–105).
- ² The notion of counterfactual has been developed in different fields of research, in particular in philosophy of science by David Lewis (1973). Given the limited scope of this chapter, I will not elaborate on the roots of this notion, which I use in a specific didactic way.
- ³ In the following, I provide a first analysis of the example within the transcript. Then I will reconsider some of these elements. «T» = teacher; «STs» means that several students are talking together.
- ⁴ The idea of 'trilogue' was proposed in didactics by M-L Schubauer-Leoni (1997). It refers to the fact that didactic communication often reunites three sources of utterances: the teacher, the whole class, and the particular student who is conversing with the teacher.
- ⁵ One may see as one of the didactic avatars of what Quine (1960) calls the *indeterminacy of reference*.
- ⁶ It is worth noting that the teacher was acting within a research team, and since then has completed a PhD in educational research (Vigot, 2014) within cooperative engineering (Sensevy et al., 2013).
- ⁷ The reader may jump directly to the synoptic table included below in this section in order to embrace in a single glance the whole set of counterfactual strategic systems and the actual strategic system.

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