

Semiosis Process in Instructional Practice

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Abstract: In this paper, we aim to show how the Joint Action Theory in Didactics (JATD) may contribute to construct a science of instructional practice. From this perspective, we propose the two concepts of student's twofold semiosis and teacher's equilibration work, which allow us to understand the instructional practice and the learning process in the same conceptualization. We illustrate these concepts and our video research methodology within two case studies. The first case study concerns tactile reading with a visually impaired student at primary school. The second case study refers to a learning situation proposed by Brousseau (2004), the *Treasure Game*, which one can see as a fundamental situation for the representational process. By contrasting the two cases, we attempt to identify two different kinds of equilibration works. We show how these two different equilibration works involve different ways of articulating the twofold semiosis in the didactic transactions.

Introduction

In this paper, we address two major issues.

First, we concentrate our analysis on practice, and particularly on the *instructional practice*. Sharing Koschmann's question "How... do we begin to construct a real science of instructional practice?" (Koschmann, 2011, p. 6), we try to provide some elements to contribute to this construction. From that perspective, we sketch a theory, the Joint Action Theory in Didactics (Sensevy & Mercier, 2007; Sensevy, 2011a; 2011b; 2011c), stemmed from French Didactics (Brousseau, 1997; Chevallard, 2007; Sensevy et al., 2005; Laborde et al., 2005; Sensevy et al., 2008), a theory which aims at linking teaching and learning by postulating that one cannot understand learning practices without understanding the related teaching practices. In this theoretical frame, "didactic" has the general meaning of "relating to the teaching/learning process concerning a specific knowledge domain".

The second issue of our paper concerns the way the teaching/learning relationship can be seen as a semiosis process - that we define, in Peirce's sense (Peirce, 1998), as the way of producing and deciphering signs - in which the teacher's action plays a prominent role. Within the JATD theoretical frame, we argue that learning needs teaching, and we postulate that the teaching learning process is above all a communicative process. In order to learn, a student needs to understand the learning situation in a right way, i.e. in the "same" way as the teacher does. Under certain conditions, the teacher and the student have "to play the same game". How can the teacher and the students acquire a common understanding of a given situation? We argue that students have to become able to see the signs in/of the situation in the same way the teacher does. They have to build an accurate *seeing-as* (Wittgenstein, 1997) in a specific *thought style* (Fleck, 1979).

The theoretical approach: the semiosis process in the joint action theory

The JATD is based on the notions of didactic game and learning game. The didactic game (Sensevy et Mercier, 2007; Sensevy, 2011a) describes the fundamental structure of the teaching/learning process. We consider the didactic game as a game in which one player (the teacher) wins if and only if the other player (the student) wins. The teacher cannot make the "winning moves" (i.e. cannot learn) in place of the student, even though she has to enact a specific guidance (Kirschner et al., 2006) to orient the students. All that he or she can do is "play" in an indirect way in order to enable the student to learn. In this regard, the student has to act in a corresponding way, and enact a first-hand relationship to the piece of knowledge involved. We have described (Sensevy, 2011b) this fundamental constraint by arguing that the teacher has to be *reticent* – the teacher must not tell the student all that he or she knows – in order to enable the student to learn on her own – a necessity we term the *proprio motu* clause. This fundamental property of the didactic game implies some other necessities that we have no space here to mention, but the main point is that the teacher's reticence and the *proprio motu* clause strongly shape the kind of semiosis inherent to the didactic game.

A learning game, which refers to the teacher's game on the student's game, can be described by relying on two elements. The first element is the *didactic contract*, an expectations system between the student and the teacher, which gathers the current habits (rules, norms, capacities) relating to the knowledge at stake, and which constitutes the current students' strategic system. The didactic contract can be seen as a system of social and socio-epistemic norms (Yackel & Cobb, 1996; McClain & Cobb, 2001) relating to the didactic institution in which the didactic process unfolds. The second related element is the *didactic milieu*, which refers to the virtual

knowledge to be acquired, as it is displayed in the learning game. This knowledge is embedded in the material and symbolic objects of the milieu, to the extent that this milieu enacts a problem.

A main feature of the didactic transactions lies in the process of reaching a kind of equilibrium between contract and milieu in the learning games. We called this process *didactic equilibration*. The didactic equilibration can be seen as a semiosis process, in which, by relying on the didactic contract, the students become able to solve the problem, i.e. to interpret the milieu in a relevant way.

In the semiosis process, the student has to produce a *first semiosis*, the deciphering of the signs of the milieu. These signs are non-intentional signs. By “non-intentional”, we mean that the signs are not directly produced within an intentional process. But this first kind of semiosis is not produced independently of the social structure in which the didactic process unfolds. It is enacted against the background of the previously taught knowledge as it has been structured in the preceding didactic joint action, the didactic contract background. This didactic contract may be seen as an epistemic system, which enables the students to cope with the milieu of the problem at stake, and a transactional system, in that the teacher may orient the student’s action in the milieu by relying on the content of the epistemic system provided by the contract. This transactional process refers to what we call the *second semiosis*. In the *first semiosis*, the student has to decipher the *non-intentional signs* of the milieu. In the *second semiosis*, she has to decipher the *intentional signs* that the teacher provides in order to orient her in the milieu.

In the following, we document this twofold semiosis and the related teacher’s equilibration work in two empirical fields. The first case study refers to a situation of tactile reading, involving visually impaired students. The second case study elaborates on a didactic situation at Kindergarten proposed by Brousseau (2004).

The methodological approach: some elements

Our theoretical frame rests upon the analysis of the joint action between the teacher and the students. As we have seen, this theoretical viewpoint gives a major importance to the production and the deciphering of signs, in the semiosis process, which is partly a semiosis of others. The teacher has to identify the signs provided by the students, and, in what we have called the second semiosis, students have to recognize the teacher’s intentional signs. Moreover, the knowledge at stake can be conceived of a symbolic system in itself, that the students have to acknowledge and practice. For these reasons, we ground our inquiries in the video recording of teaching/learning practices, and we include our approach (Forest & Mercier, 2011) in the methodological paradigm of the Video Research (Goldman et al., 2007). As we have argued elsewhere (Sensevy, 2011a; Tiberghien & Sensevy, in press), video recordings enable to keep the *analogical* character of the situations with its specificity and its density of information (Dretske, 1981). Above all, as Goldman & McDermott (2007) state, it makes communication visible, and allows accounting for the embodied *instructional communication*. Our methodological endeavor consists of building what we call hybrid texts-images systems, in which is fostered a reciprocal annotation process between texts and images.

Case study 1: Visually impaired students

General description of the situation

The first situation we present involves tactile reading. Visually impaired students (5 years old), are trained by a special teacher to read a tactile book, which name is “Little point draws a man”, and which is structured as presented below.



Figure 1: 3/9 pages showing the structure of the tactile book “little point draws a man”.

The teacher decided to give the book to the visually impaired student without reading it to her. The student had to recognize the shapes without any information. She first recognized “the head” of the man and the studied episode takes place when the student has to identify what she first called « the sweater » of the man.

Solving the problem of representation: an oval for the belly

The student has just turned the page and she is exploring the tactile representation, i.e. a new piece of fabric below the head that she has previously identified.

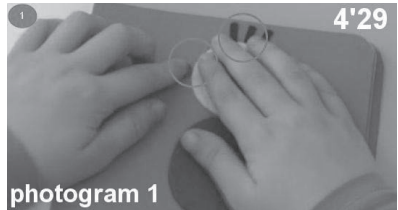

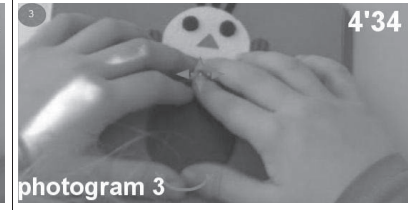
 <p>photogram 1</p>	 <p>photogram 2</p>	 <p>photogram 3</p>
<p>General location phase: the student uses the left index to locate the “ear” element, while the right hand recognizes the whole element “head”. In the same time the thumb starts to explore the new element (the “belly”).</p>	<p>Specific exploration phase (1): the student enacts a vertical exploration of the new element.</p>	<p>Specific exploration phase (2): hemispheric dissociative exploration. In particular, she focuses on the hinge between the « head » element and the new element.</p>

Table 1: first tactile exploration, in a silent way

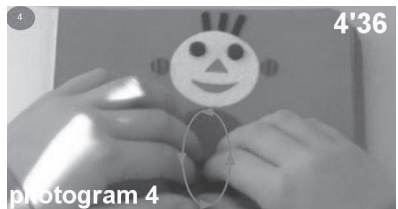
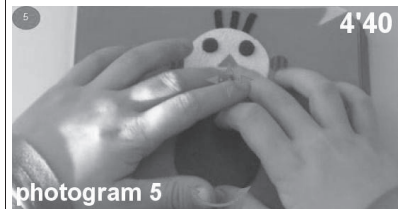
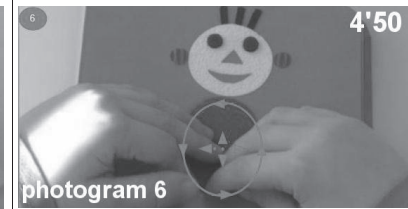
 <p>photogram 4</p>	 <p>photogram 5</p>	 <p>photogram 6</p>
<p>Specific exploration phase (3): the student focuses on the new element. She feels the texture of the new element.</p>	<p>Specific exploration phase (4): the student verifies the specific location of the “belly”</p>	<p>Specific exploration phase (5): the students explores the new element, in search of new differential properties (other than texture)</p>
<p>S (Student): <i>The sweater+</i> T (Teacher): <i>This is the sweater?</i> S: <i>Ups! no</i></p>	<p>T: <i>What can it represent, according to you?</i> S: <i>The belly</i> T: <i>what is the shape of the belly? + can you tell me the shape?</i></p>	<p>S: <i>round, mm</i> T: <i>It's a round? I do not totally agree</i> S: <i>an oval</i></p>

Table 2: exploration with joint verbal action

Tactile reading: the twofold semiosis process and the teacher's equilibration work

In this episode, from the student's point of view, the twofold semiosis means a milieu semiosis (S_M), the first semiosis, and a teacher semiosis (S_T), the second one. The learning game at stake is a “form recognition” game, i.e. a game where the student must identify the forms she touches on the book. The epistemic elements of the didactic contract on which the student relies are the prototypic body image, her textures knowledge, a “common geometric” knowledge, and the “currently taught” geometric knowledge. The student explores the didactic milieu constituted by the different elements of “the man”. The fact that the student is visually impaired put forward the necessity she meets to explore the didactic milieu, as the annotated photograms show. The relationship to the milieu is a necessary condition of her learning. Nevertheless, as we will see, the didactic contract plays a prominent role in this episode. We can describe the didactic transactions in this excerpt according to four phases.

Phase 1: ($S_{M/T1}$). The semiosis is oriented to the milieu (First Semiosis), following the teacher's general indication. It's the meaning of the symbolic notation $S_{M/T1}$: a semiosis of the milieu (first letter M), following the teacher's orientation (second letter T). The student explores the specific location of the new element in the body image and relies on its texture. She finds a first answer (*The sweater*), by focusing on one may call a *non-intentional sign* (the fabric on the tactile book)

Phase 2: Then the teacher asks a question (T: This is the sweater? ...What does it can represent, according to you?) (S_{T1}). Here the student's semiosis is of the second kind. The student deciphers the teacher's signs, against the background of the didactic contract. One can make the hypothesis that she has understood that the game is about the parts of the body, she identifies an *intentional sign*, and she answers by guessing the likely teacher's expectations (*The Belly*)

Phase 3: Then the teacher asks a new question (T: What is the shape of the belly?)(S_{T2}). Again, the student's semiosis is of the second kind. The teacher's word “shape” probably allows her to identify the geometric didactic contract, which rule this transaction. She understands she has to focus on the geometric property of the belly, and she answers with this respect (*Round*).

Phase 4: Now the teacher tries to obtain a better “geometric” response from the student (T: It’s a round? I do not totally agree)(S_{T2/M2}). The student’s semiosis continues to unfold in the deciphering of the teacher’s signs (her utterances). She explores the form of the “belly” and produces a new answer (*Oval*).

This case study enables us to make a clear distinction between the two forms of semiosis. At the beginning of the episode, the student really faces the milieu, and she has to decipher the tactile signs by relying on her knowledge of the body image and the texture she recognizes. But after this first kind of semiosis, she has to take into account the teacher’s questions and assertions. In doing that, she orients her deciphering towards the expectations of the teacher, that she interprets against the background of the didactic contract.

From the teacher’s action viewpoint, one can recognize an equilibration work in which *the milieu is an auxiliary to the contract*. Everything occurs as if the main intention of the teacher was to elicit some words (belly, oval) that the student already knows. The milieu, and the exploratory work of the student in this milieu, has the main function of producing the “right” predefined seeing-as: “seeing” the “sweater” as a body part; “seeing” the “round” as an oval.

Case study 2: The Treasures Game

General description of the situation

Brousseau and his team designed the *treasures game* for kindergarten students at the beginning of the nineteen eighty. This learning sequence takes place over several months and it aims to have students build a system of graphical representations. Brousseau (2004) has presented a strong theorization of this research design, which he considered as a fundamental situation for the notion of a *representation*. The situation was recently re-implemented in some classes in Switzerland (Leutenegger & Ligozat, 2009) and in France. It consists of producing a list of objects to be remembered and communicated. The game is organized in four stages, the rules changing as the game progresses.

In the first stage, the teacher presents two or three small new objects each day. These objects belong to the world of children and are passed from hand to hand. The teacher asks the students to name them, and she puts them in a box (the treasure chest). Then she asks: what’s in my box? A student then calls out the name of an object, the teacher pulls the object out of the box and places it in full view. Then she asks “Is my box empty?” and if not, the game continues, and so on.

Every two or three days, two or three new objects are presented by the teacher and are added to the previous ones. At the end of one month, the whole class can empty a box of 40 objects (thus being able to *collectively* memorize 40 objects). These objects can seem disparate but they were carefully chosen. One can look at some examples of objects on the figure 1, including “the lens” and “the pan” which will support the problem of representation in the episode we will study in this section.



Figure 2: some examples from the reference collection of 40 objects.

This stage is played out with the *entire group* of students and focuses on the *creation of a verbal system of reference* for the objects inside the treasure chest.

The stage 2 proceeds in two memory games. Firstly the students have to play an individual memory game, as each pupil must individually remember 3 objects that are daily hidden in the treasure chest. But when all the pupils have understood this memory game with 3 objects, the teacher introduces an important change: she asks each pupil to remember ten (10) hidden objects. This *informational leap* makes it impossible to win only with an “internal” memory. The jump from 3 to 10 objects is intended to oblige pupils to produce individual graphical lists, in order to remember the specific objects and win the game.

The stage 3 aimed at communicating with lists. This new part of the game takes place in small groups of 5 pupils. 4 object representations are written by a pupil, who is “the designer”, and these objects are hidden in the box. The other 4 pupils have to “read” the graphic representations of the designer, and name each object to get it out of the box. This third stage gives pupils opportunities to debate, firstly in their small group, and secondly in the whole classroom during the 4th stage of the game.

In stage 4, the pupils are building a common code for the whole class. In the studied carrying on of this engineering, stage 3 and 4 are intertwined. Some changes in stage 3 prepare the debates in stage 4.

Solving the problem of pan's representation

The small episode we study takes place in stage 3, when pupils have to read the representation of the designer.

On this episode, the teacher gave the designer four quite different objects; one of them is “the pan” (cf. fig.2, above). When students have to “read” the designer's



Figure 3: the representation of the pan by the “designer” student

production (cf. fig.3, shown against), they fail to recognize “the pan” (the designed object, fig. 2, above), confusing it with “the lens”, another object of the collection of reference, which have a similar form (cf. fig.2, above). In the short moment of joint didactic action we present, *the teacher has first shared with the students the failure of the designing and recognizing the pan.* She then asks students to find some ideas to draw and recognize the pan better.

Like in the previous example, our description and analysis use a hybrid system with photograms, utterances and commentaries on twofold semiosis. The English discourse is a translation from French. The commentaries are informed by proxemic analysis (Hall, 1966; Forest, 2009) of non-verbal behaviors.

Table 3: giving the problem

	<p>Iman: <i>we have to make a small line, we have to do this...</i></p> <p>The teacher shows the object in her left hand, and its representation (cf. fig.3 above) by pointing it with her finger, in her right hand, and asks the students for a comparison. A student, Iman, points a part of the object, which is characteristic of it (a hole on the handle). In that way, the student links a sensory feature to a specific characteristic of the object, which is potentially relevant to solve the problem. One can notice the direction of the student's eyes as an indication of a joint semiosis between the teacher and the student.</p>
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At this moment, the local learning game consists in representing in a better way the pan, in order to distinguish it from the lens. By showing the object and its representation, the teacher gives the student the specific problem of the distinction lens-pan in the graphic representation.

According to the teacher's expectations, the student (Iman) acts in the milieu, and suggests by pointing on the object that it would be accurate to represent the hole (*we have to do this*). We can argue that the student plays a relevant move in the representation game by deciphering the signs of the milieu (semiosis 1, she indicates a possible characteristic to design). Even though she responds to the teacher's expectation (semiosis 2), she positions herself as a potential provider of relevant design features. The semiosis is of the form ($S_{M/T}$).

Table 4: another strategy is proposed

	<p>Iman: <i>a big ring, and for the lens a small ring</i></p> <p>The teacher looks herself at the representation drawn by the designer (cf. fig.3 above). She points it by her left hand finger. Iman “writes” with her finger on the table by evoking a possible representation of the difference between the pan and the lens (big ring-small ring).</p>
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By showing the representation to the students, and looking herself at it, the teacher drives student's attention onto the design. Iman tries to draw on the table, and a generic sign emerges (a ring). But the representation “big-small” is not a distinctive sign (which may allow to recognize the object in itself) and it will not really work if only one object (the lens *or* the pan) is to be recognized among others: in this case only the pan is represented, and the comparisons of representations (between the lens and the pan) cannot work.




Interpreting in a general way the teacher's expectations about the drawings, the student produces a kind of strategy which can be useful, but which is not a winning one in this specific learning game. Even if it is relatively ineffective, the semiosis is always of the form ($S_{M/T}$), in that it enables an explorative and imaginative inquiry into the milieu, not oriented to pre-conceived meanings.

Table 5: the less relevant strategy starts spreading

	<p>Another student: <i>...a small ring, and a stick</i></p> <p>As in table 3, the teacher shows the object and its representation. Again, she asks the students for a comparison. Another student writes with his finger on the table, as Iman did. He repeats Iman's proposition (a ring), <i>adding the possibility of drawing a stick</i> (for the handle). It's worth noticing that the attention of the students focuses on Iman's action. The teacher's attention is oriented to the last student who had made a proposal.</p>
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The teacher goes on showing the object and its representation in order to have the students “comparing” them, but Iman's proposal is taken up and meliorated by others. The new proposal (a small ring and a stick) possibly solves the problem of a generic representation for the pan and the lens. From this point of view, it is relevant. But it doesn't work as a distinctive representation between the two objects. So it is less relevant in this representation game. The enacted semiosis is of the same kind as the previously analyzed (S_{MT}). The students are oriented by the strong teacher's guidance, but in an open way, which allows them to propose different representations.

Table 6: the teacher do precise the problem

Showing the pan and its representation, the teacher reminds the students the current difficulty (<i>we had confused with the lens</i>). One can notice the central posture of the teacher, and the convergence of the children's eyes.	Staying in her posture in front of the students, the teacher moves the object and its representation on her left side. In the same time, she reformulates the problem, relating to the lens (<i>so that one guesses every time that it's the lens...</i>)	Moving on her right side, near the designer, she formulates the problem for the pan. When talking, the teacher directs her eyes toward different children, finishing toward the designer.
		
The teacher: <i>It's true that we had confused with the lens, because it was like the drawing of the pan.</i>	<i>We should try to find a drawing for the lens, so that one guesses every time that it's the lens...</i>	<i>...and a design for the pan, so that one guesses every time that it's the pan...</i>


One can see, at this moment, how the teacher works in the semiosis 2 (the student's deciphering of teacher's signs) to take on the issues of the learning game (*we had confused... we should try to find a design... so that one guesses every time*).

However, the teacher remains reticent. To support her reticence, she uses the resources of the proxemics, joining gesture to her talk: first, she shows the object and its representation like in the photogram 1, showing them to all the students; second, she evokes the lens (which is absent from the package) putting the pan and its representation on the left side; third, she moves on the other side to finally show the representation which failed, to the designer.

The learning game is strongly restated at this time (*a drawing for the lens/the pan, so that one guesses every time that it's the lens/the pan...*): the students have to produce by themselves a strategy to design the pan, while taking into account its similarity with the lens.

One can analyze this episode by relying on the contract-milieu dialectics within the learning game. In order to explore the milieu (to inquire into the different ways of representing the objects) in a relevant way, the students have to play the right game. The students have to become able to differentiate some very similar objects (from the students' representational viewpoint), as the pan and the lens. In this perspective, the teacher's monitoring consists of reminding these contract rules, which embed the end-in-view of their game.

Table 7: Joint action provides a new relevant move

	Tilio: <i>Ah yes! so one can make a small hole here.</i>
The teacher continues showing the object and its representation. A student (Tilio) points a part of the pan, the same that Iman had pointed on table 3. We can perceive the convergence of student's gaze on Tilio's gesture.	

According to the teacher' expectation, Tilio acts directly into the milieu, by pointing the hole on the object and by naming it (*a small hole for the handle*). In a more theoretical language, we can say that Tilio deciphered the teacher's expectation (semiosis 2) about the playing of the “right game”. He then plays a relevant move in the representation game, by deciphering a sign of the milieu (semiosis 1), and categorizing it in an efficient way. In effect, if the representation of the pan includes “a small hole” on the handle, it will allow to

differentiate the pan from the lens, even though if the general form of the two representations is similar (a small ring and a stick). Tilio's move will be followed by other students and his proposal will be institutionalized. Once again, the semiosis process is of the form (S_{MT}). The students produce imaginative and accurate ways of seeing the milieu, but one has to keep in mind that such performance is made possible by the enduring teacher's work.

The Treasure Game: the twofold semiosis process and the teacher's equilibration work

According to us, the above analysis is in line with a transactional perspective (Clancey, 1997, 2001; Koschmann, 2001, 2011), which looks at the teaching-learning process from a Deweyan viewpoint. In that way, we agree with Koschmann's contention according to which "Deweyan inquiry, when successfully carried out not only effects a change in the problem solver (what psychologists treat as "learning") but also leads to a reconstruction of the problematic situation that led to the inquiry in the first place" (Koschmann, 2011, p. 12).

In the Treasure Game situation we have presented in this paper, one may appreciate an actual form of inquiry endorsed by young students (5 years old). The theoretical categories of the Joint Action Theory in Didactics enable us to understand what could be the sources of such an inquiry. Grounded in a representation game, this situation entitles the students to propose signs as means of representing objects. But this game does obey to strict rules, as we have seen above. If a sign does not provide the collective with a successful way to recognize an object, it has to be rejected, not by the teacher, not even by the students, but in the unfolding of the actual game (at is was the case at the beginning of the studied episode).

It's worth noting that such a situation does not achieve its goal without a specific teacher's equilibration work. One can imagine two opposed counterfactuals in order to figure out this point. In the first counterfactual, one can think about a teacher who would abandon her reticence, and try to directly influence the students, for example by immediately rejecting the ineffective signs, or by proposing one particular "good" sign to the students. In the second counterfactual, one can envisage a teacher who would let the students explore the milieu, for example without reminding them the overarching goal of the learning game. In contrast with these both counterfactuals, in the actual situation, the teacher enacts a third way of doing. She provides the students with a system of meanings, embedded in the signs she uses, while keeping a strong reticence about the representational knowledge in question. In her equilibration work, the contract can be seen as an auxiliary to the milieu, which means that in the twofold semiosis that the students enact, the deciphering of the teacher's signs gains its sense firstly as a way of carrying out the inquiry (Dewey, 1938/2008).

Discussion: an outline of a comparative analysis

The comparison of practices in the two case studies could provide an exemplar, in Kuhn's sense (Kuhn, 1979), of two possible relationships between the student's deciphering of signs and the structure of the instructional process. In effect, in the first case study (Tactile Reading by a visually impaired student), the twofold semiosis is mainly of the form ($S_{T/M}$), even (S_T). It is to say that the student, when she explores the milieu, does it by enabling herself to recognize the didactic contract meanings that stand as a background against which she acts. Her agency is constrained by the predefined meanings that the teacher has in mind (i.e. "belly" rather than "sweater", or "oval" rather than "round"). In this perspective, *the teacher's equilibration work is contract-driven*, in that her main intention consists of making the student more familiar with a specific seeing-as (*see the round as an oval*) in a particular though style (the geometric though style), that has been previously studied.

By contrast, in the second case study (The Treasure Game), the twofold semiosis is mainly of the form (S_{MT}). The deciphering of the teacher's signs, in the second semiosis, is never an end in itself. The main function of this second semiosis consists of making the student able to carry on the inquiry process. The didactic contract stands as a background for the student's activity, in that it orients in a decisive way the students' action (the weakness of the contract would be very detrimental to the joint action), but it is not sufficient to reach the learning games goal. The more important feature of the students' activity lies in their inquiry process into the milieu (i.e. becoming able to "invent" effective representations), and rests on the way they endorse the first semiosis. In that way, the structure of the learning game fosters students' agency.

In this perspective, *the teacher's equilibration work is milieu-driven*, in that her main intention consists of making the students able to enter the representational process by directly understanding the nature and properties of signs through the consequences of their decisions.

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