Teaching action in physical education: A cognitive anthropology approach

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In this lecture, I shall present an anthropological approach to teaching physical education. I first propose a conceptual framework, and then illustrate some of its principal dimensions using the results of studies. P.E. teaching is analyzed as an action that has a number of unique properties, but that also has the generic features of all human action: it is goal-oriented and meaningful, it is organized, and it develops in a physical, social, and cultural context. The theoretical assumptions underlying this research project are based on a conception of action that can be summarized in three points: action is a situated activity, action is a meaning-building activity, and action has self-organizing properties. The main purpose of this project is to contribute to the development of a theory of teaching in physical education. I shall deal in-depth with each of these three basic theoretical points and illustrate them with data obtained from various studies.

1. PHYSICAL EDUCATION TEACHING AS A SITUATED ACTION

Action is an accomplishment that takes place in a context and bears the mark of that context (Conein and Jacopin, 1994; Hutchins, 1995;

The José María Cagigal Lecture at the AIESEP World Congress Adelphi, 1998.

Kirshner and Whitson, 1997). From the standpoint of lived experience, the context must be distinguished from the situation. The context is the "already-there", the background of the action; it is endowed with an objective existence, an organized set of elements that does not prescribe the action, but "proscribes" certain aspects of it (Varela, 1998). It is a set of virtualities within which an actor, by becoming involved, defines, delineates, and opens up a field of possibilities (Lave, 1988; Suchman, 1987). The situation, on the other hand, is constructed by the actor and has no existence outside of the action he or she produces: it is thus both its product and its condition for existence (Varela, 1987).

The action-situation coupling takes shape in a complex and enigmatic world that the actor specifies and renders meaningful by making use of what the world affords to him for acting (Norman, 1993). These affordances are the "resources" or raw materials of the action (Lave, 1988), and the objects are "cognitive artifacts" (Norman, 1988) and potential conveyors of knowledge and meaning. Other people are a special kind of "action resource": in collective actions, cooperation among actors draws upon the aid-to-action that each participating person represents (Resnick, 1991; Salomon, 1993).

A few of the characteristic features of situated action are presented below. They concern its spatiotemporal framing and the emergence of instructional formats.

1.1 Spatial and Temporal Framing of P.E. Teachers' Actions

I shall illustrate the situated nature of a teacher's action by analyzing two gymnastics lessons, given to the same class. Both lessons consisted of an initial phase during which the teacher organized the available work time and space, and then an actual instructional interaction phase. In Lesson No. 1, the teacher set up four work stations (or workshops), one for each skill the students were supposed to learn. The class was divided into four groups that rotated from one station to the next every 20 or 25 minutes. During the lesson, the teacher moved around the room in the opposite direction to the students. He stayed two or three minutes at each workstation, reminding the students of the instructions, giving feedback, and providing work incentive. He made four stops during each of two complete (or nearly complete) rounds. For Lesson No. 2, the teacher set

up four parallel work stations lined up along the floor, divided the students into four groups, and had all groups work on the same skills. The students did the exercises individually, each one waiting his/her turn next to the mat. The teacher walked back and forth in front of the mats, interacting with the students (Figure 1).

Although the students, the goals, and the sport were the same in these two lessons, the teacher's actions had some unique features in each case: the interactions were directed at groups or individuals, equal chances were given to groups or to individuals, the interactions were planned or improvised, they varied in regularity and spacing over time, and teacher-student contact was more or less continuous.

During Lesson No. 1, 27% of the teacher's verbal interaction time was directed at the entire class, 48% at a student group, and 25% at an individual student. The different groups were in direct contact with the teacher for comparable amounts of time that ranged between 22% and 27% of the total interaction time (the groups worked without supervision between 78% and 73% of the time). Only 12 out of 27 students interacted one or more times with the teacher during the lesson. The teacher's actions were ordered and distributed in a regular way during the period. During Lesson No. 2, 37% of the interaction time was spent talking to the whole class, 18% to groups, and 45% to individual students. The total interaction time differed across groups, with Group 1 obtaining 22% of the time, Group 2 40%, Group 3 30%, and Group 4 8% (due to the route taken by the teacher, the two groups in the middle were visited more often). In this lesson, 22 out of 26 students interacted directly with the teacher at least once. The distribution of the interactions over time was irregular and resulted from the teacher's back and forth motion.

A teacher's action amounts to selecting elements of the context he/she feels are relevant and then organizing them. These elements include the spatial arrangement and the use of time, the establishment of student groups, the format and content of teacher-student communication, and the different ways of assessing scholastic achievement. The two lessons just described relied on different ways of utilizing the resources of the particular context, namely, space, time, instructional materials, sports equipment, and the students' capacities for independent work, coopera-

tion, attention span, and effort. This process of selection and organization leads to the emergence of structured sets which define "instructional formats" (Gal-Petitfaux and Durand, submitted).

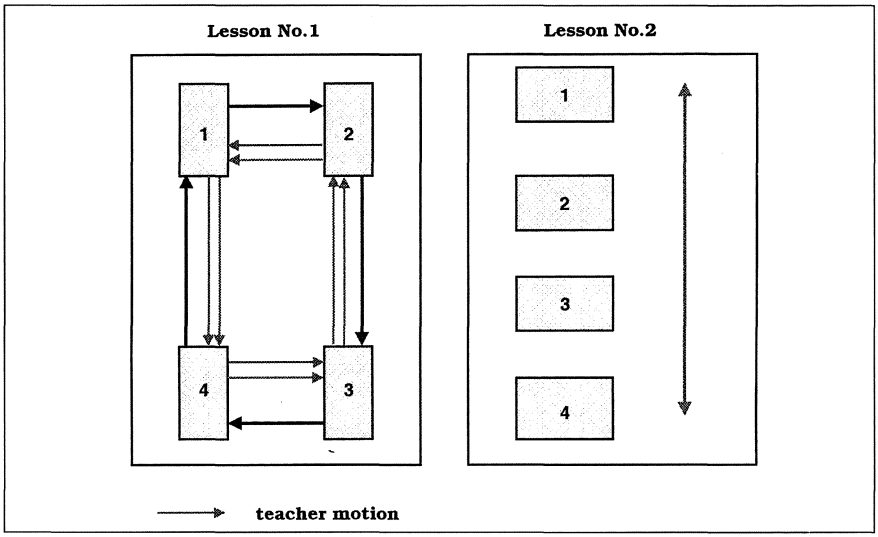

Figure 1. Location of workstations and teacher's and students' routes during gymnastics lessons.

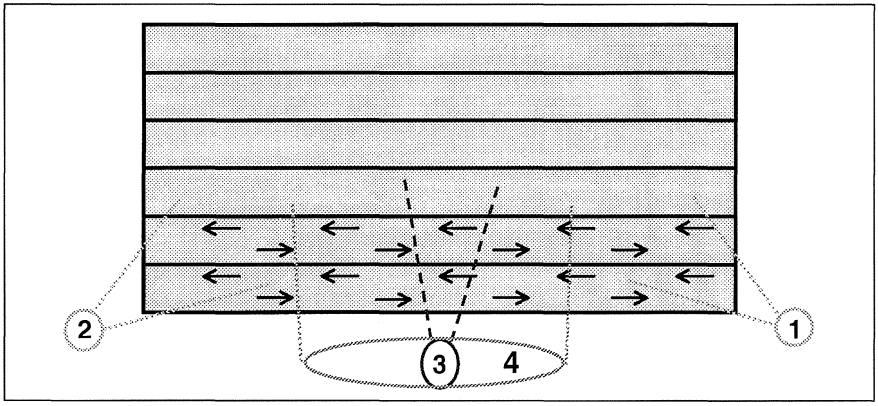

Figure 2. Teacher's locations and routes taken during swimming lessons (the students are shown as black arrows).

1.2 Emergence of Instructional Formats

For swimming, we have observed three typical instructional formats. All three take advantage of the students' motion as they do single file swimming exercises in two lanes of a pool (Figure 2).

In the first format, the teacher stands in Area 1 or 2 and remains stationary. He speaks either to the class as a whole or to individual students. He gives instructions about the exercises to carry out ("You are going to get a board and do the crawl stroke for two laps") as well as individual reminders about following the instructions: order in the lane, controlling swimming speed, coordinating actions among students, etc. ("Don't stop", "Don't wait until your classmates come back to start"). In the second format, the teacher gives the instructions to the class from Areas 1 and 2 and then goes to Area 3 and stays there. He addresses the students individually as they pass by the "window" defined by the rectangular surface of the water immediately in front of him. His gives quick feedback about the various swimming movements ("Breath out in the water like this", "Lie down, you're not lying flat"). In the third format, after giving collective instructions from Areas 1 and 2, the teacher goes to Area 4 on the side of the pool and moves around inside that area. His walking is dictated by the moving swimmers. He selects a student, focuses his attention on that student, paces his walking after the student's swimming speed for 4 or 5 meters as he talks to him, and then "deserts" that swimmer to select another student who is moving in the opposite direction, and so forth. The teacher's remarks are lengthy and individualized; they are feedback that depend on what was just observed in the interaction zone. He points out how the swimmer might correct certain movements and then evaluates the corrections made. His remarks pertain to the dynamics of the swimming movements and the continuity of the propelling actions ("Try to kick your feet a little less and put your hips to work ... and bring your feet up a little back there ... You're not bringing them up enough ... There, I like that better ... There, ok ... Bring your feet up towards the inside ... That's good ... That's better, like that ... I like that better ...").

These instructional formats are the product of local interactions between different elements: the number of students, the type of forward movement (slow swimming in a straight line), the small available work

area (two swimming lanes), the poor conditions for communicating with students in the water, difficulty observing underwater movements, etc. As such, the formats are not solely dependent upon the configuration of the pool space, nor are they inherent in the teacher's actions. They are "artifacts" located at the interface between the actor and the context. They are more or less successful at fulfilling the various teaching functions, which are (i) defining and structuring course content, (ii) organizing the work and circulation of students in a way that initiates activity and offers each one the same learning time, conditions, and opportunities, (iii) observing the students' activity and monitoring their work in such a way that their actions become conspicuous and can therefore be evaluated, and (iv) facilitating verbal and nonverbal communication in order to assist and optimize the students' activity. Instructional formats incorporate a variety of factors such as the size, shape, and organization of the action space, the duration and structure of the action time, the teacher's moves and distance from the students, the relating mode (individual, small groups, entire class), the content of the teacher's remarks and feedback, the course material, the decision-making methods, and initiative-taking in class. They are closely tied to the kind of learning (discovery, problem solving, movement repetition and automation, imitation), the types of motor skills or coordination required (open or closed, cyclical, discrete or continuous), whether the students are stationary or moving (speed, direction, distance), the attentional demands on the students in action, whether the students' activity is collective or individual, and how the students relate to each other (cooperation, competition, in parallel).

2. SIGNIFICANCE OF P.E. TEACHERS' ACTIONS

Situated actions construct meaning (Brown, Collins, and Duguid, 1989; Derry, 1992; Whitson, 1997). I shall analyze action from a semiotic standpoint based on Peirce's "thought-sign" hypothesis (Saury, Durand, and Theureau, 1997; Theureau, 1992). Three concepts underlie this analysis: (i) action is organized as a chain of nested elementary units, (ii) these units are meaningful, and (iii) they are supported by structures which are isomorphic to the triadic signs described by Peirce (1931-1935).

Although seen as a continuous flow, action is hypothesized to be decomposable into elementary elements or units that can be classified into the following five categories (Theureau, 1992): practical actions, which are actions rooted in physical changes in the environment; communication, which are directed towards changes in the mental state of the persons interacting; interpretations, which are internalized actions or operations that may produce thought chains or private speech; focusing, which involves perceptual or cognitive concentration on delineated entities; and feelings, which are emotional and affective manifestations that are more or less differentiated and more or less pleasant or discomforting. One and the same action unit can fall into several categories.

Action can be understood at different scales, and its analysis can be coarse or fine-grained. We shall study action here at the level where it is significant for the actor, that is, where meaningful action units can be evoked. We shall make use of properties like "cognitive penetrability" to identify what part of an action is meaningful for the actor, in other words, that which the actor can tell, comment upon, and show at any time (Theureau, 1992). This breakdown into meaningful elementary units (hereafter called MEUs) places priority on the intrinsic properties of the action, and hence on the meaning of the action as it is understood and verbalised *by the actor.*

Each MEU is considered to have an underlying structure: a triadic sign (Theureau, 1992). Its meaning results from the relationship between the three components of the sign: the object, the representamen, and the interpretant. The object refers to the mode of involvement, the "being-in-the-situation", the field of possibilities opened up by the actor's involvement; it pertains to his or her intentions. The representamen refers to whatever in the situation is a sign (an anchoring point) for the actor, who makes a perceptual judgment (an affordance) or a mnemonic judgment (a reminiscence). The interpretant refers to the element of generality that relates the representamen to the object. Interpretants are the constituent types of the actor's culture and experience, and are actualized as "rule following".

Table 1 - Object, representamen, and interpretant of the MEU «Going from station to station while observing students» during Phases 1, 2 and 3.

	Object	Representamen	Interpretant
MEU No.1	Checking work of all students	Acceptability or unacceptability of the noise the students are making at each workstation	Students work well when teacher is close by Students tend to minimize school work All students go through same learning stages
MEU No.2	Promoting execution of instructions by all students	Following or not following instructions to stretch out legs	Students are not capable of careful work Following instructions is a basic condition for learning Progress in gymnastics depends on strict adherence to instructions
MEU No.3	Helping certain students make a discovery	Feeling that students are or are not on the verge of taking a step	Learning is a discontinuous and qualitative process Effective aid can only be provided when students are ready for motor reorganization

2.1 Intrinsic Analysis and Significance of P.E. Teachers' Actions

The significance of a P.E. teacher's action can be studied via a local analysis of data obtained through observation and self-confrontation. This data is collected during sessions where the teacher is shown videotapes of his/her actions and, guided by the researcher, retrieves, relates, and makes comments about them.

The example below concerns the significance of three apparently identical phases of a teacher's action. After having set up work stations in a gymnastics class, the teacher goes from station to station and watches the students. This outwardly simple action unit can be labelled "Going from station to station while observing students." A local analysis based on the self-confrontation data showed that hidden under their identical surfaces, these three phases have very complex and different meanings.

Phase No. 1

Researcher:Are you observing?

Teacher: I'm walking around between the mats, I'm not really looking at what they're doing. I know what they're going to do, all students go through the same stages in gymnastics. No I do it this way, this is what typically happens in a gymnastics class, there's nothing special here, so things move on their own.

Researcher:Are you going over to some specific spot?

Teacher: I'm ... I'm listening to the noise. You see, here, something's going on. The two students in the back, I'm going over to them and they calm down. I'm using the noise as a clue, you might say. You see when I approach, everybody knows, they'll stop acting up. They'll start to work. That's what tells me.

Phase No. 2

Researcher:And here, as you walk along, who are you watching?

Teacher: In fact, it's ... I mean, I'm looking to see whether their legs are stretched out, it's very important in this exercise to have your legs stretched out, otherwise, it serves no purpose. Here I'm looking mostly at the ones who are bending.

Researcher:Are you interacting with this student?

Teacher: Yes, you see, Nick isn't following the instructions to stretch out his legs. I'm asking him to follow the instructions. In gymnastics, students have to stick closely to the instructions. I want accurate work: without it, no progress. But they can't concentrate any more, I have to constantly tell them off.

Phase No. 3

Researcher:Are you watching, here?

Teacher: I'm looking for students who're going to figure it out ... So, you see, Martin here, I get the feeling he doesn't get it at all ... No use talking to him. But others may be on the verge of picking it up, that's the only way you learn ...

Researcher:What are you looking for?

Teacher: I'm sensing things, I'm trying to feel the movements they're making, I'm looking to see who is about to take a step ...

Researcher:Are you going over to this work station?

Teacher: I'm going over there because I saw something.
Researcher: What did you see?
Teacher: It's Mary, she's a student I like, I'm super pleased with her: she did something on the round off. She's working on getting a feeling for passing over the hands. I'm going over there so I can help her the next time.

The components of the triadic signs for these three MEUs - all called "Going from station to station while observing students" - differ considerably (Table 1).

The significance of the elements in this teaching situation also differ. To illustrate, the respective meanings of the students, the teacher's role, and the learning itself associated with these actions are given in Table 2.

This example illustrates the ever-changing nature of the meanings constructed during action. It also shows how taking a global approach to the pedagogical and didactic conceptions of teachers is an oversimplification. This example is a typical case of the kind of increasingly fine fluctuations that take place in a dynamic coupling with the situation: the involvement modes and the meanings are not "frozen" or algorithmic; on the contrary, they are undetermined, emergent. These three phases also illustrate how complex and highly varied this action is.

Table 2 - Significance in action of certain aspects of gymnastics teaching.

	Students	Role of teacher	Learning
Phase No.1	Try to minimize school work	Encouraging work, foreseeing and preventing misbehavior	Going through a standard behavior sequence, identical for all students
Phase No.2	Willing to work but don't pay attention	Issuing precise instructions and making sure they are followed	Integrating and internalizing rules and instructions
Phase No.3	Involved in seeking motor efficiency	Sensing what students feel or understand in order to help them	Personal cognitive and motor reorganization

2.2 Involvement in Action and Practical Reasoning

In everyday situations, teachers take advantage of common knowledge, and their involvement is based on judgments of typicalness. In Phase No.1, the teacher states: "This is what typically happens in a gymnastics class", "I'm not really looking at what they're doing. I know what they're going to do, all students go through the same stages in gymnastics." He discerns the typical characteristics of the situation or rather, the absence of atypical characteristics ("There's nothing special here"), and based on generalizations and typifications, makes use of knowledge which itself is typical.

If a problem arises, that is, when the expected effects are not obtained or when new events arise (Durand, 1998a), teachers either turn to a different typical coupling, or they innovate.

Table tennis lesson, 16-year-old students

Researcher: This doesn't seem to be going as you'd hoped ...

Teacher: It's Lucy and Gail, they don't understand what they're supposed to do, I can see that right away - continuing the same exercise with them is useless ...

Researcher: How can you tell?

Teacher: No change in the way they play, they're in a rut ... so it's time to change. I'm a little surprised because this exercise is usually effective with players like them.

Researcher: What are you saying to yourself?

Teacher: Here I'm telling myself that I was wrong about them. So I'm trying something else, another exercise that works too. You see, I play around with things a lot. If one thing isn't working I try something else.

Researcher: Do you try to understand *why* it's not working?

Teacher: No not here, not always, you shouldn't always try to figure it out. No, it's easier than that: if it works, I continue, if it doesn't, I try other exercises. It would take something really big, for me to start analyzing. In any case, here, I didn't try to understand, but I will remember that this doesn't always work.

Volleyball lesson, 15-year-old students
Researcher: Did you plan this exercise?
Teacher: Yes.

> I don't teach volleyball like everybody else. It's a technique I've been using for a while and it works well ... it was a revelation for me. I couldn't understand why the students didn't fight for the ball: they would stand their passively. That bothered me for quite some time. I tried a few things that never worked and then one day, it dawned on me when I saw a student dive for the ball. I got this idea: Certain students play the ball and others defend and attack a camp. Afterwards it was obvious that these camps had to be materialized and that the difference between attackers and defenders had to be made, as in other team sports. And it usually works. Since then, I've been using this exercise. It helps them understand defense and offense, and it forces them to move. In fact, I'm currently writing an article for a P.E. magazine.

In the table tennis lesson, the teacher proceeds by trial and error. He does not attempt to analyze what is happening and limits himself to known solutions. The monitoring process is simple: if it works, the current action is continued, and if not, other known actions are proposed. This action regime is based on typicality and rules, but it has the fuzzy, undetermined property of all human action (Tiercelin, 1993): ordinarily appropriate actions can also prove ineffective. The teacher states that he will remember this: he defines a generally applicable type of action and then restricts the conditions for its use. In the course of this episode, his professional experience and competence are enriched, but they are not modified at a deeper level.

In the volleyball lesson, the teacher searches and gets involved in another way: he actively constructs knowledge during action. Although he had been failing and did not know why, he devised an interpretation of his failure and found some plausible solutions. This is a case of everyday situated learning (Lave, 1988; 1997) that leads to a reorganization and the production of a new type. This production emerges as an insight following a lengthy cognitive maturation. It is an abduction process (Peirce, 1931-

1935), i.e., a practical reasoning process (Smith, 1988) through which a teacher generates hypotheses and selects the most relevant among them. The construction of knowledge in action is a key point in the development of the professional and cultural competence of teachers; it is based on a process of contagion of ideas (Sperber, 1984).

3. ORGANIZATION OF P.E. TEACHERS' ACTIONS

A teacher's action is conceived of as autonomous in essence, and irreducible to the mere influence of extrinsic factors (Durand, 1998b; Durand and Arzel, 1998). The construction of this action, that is, the chaining and nesting of MEUs, is a dynamic process that takes place at the time the action is being produced. The step-by-step construction of a dynamic whole may rely on cognitive anticipations, but it is never totally driven by them. The dynamics of this process can be reconstructed *a posteriori* by identifying its elementary units and the dependency relations between them. Affirming this autonomy (even if only relative) implies recourse to an explanation system based on the self-organizing properties of complex systems (Dumouchel and Dupuy, 1983; Smith and Thelen, 1992; Varela, 1987).

3.1 Coordination of Archetypical Sequences

Physical education teachers who are concerned about student participation and team work often set up workshops where groups of 4 to 8 students collaborate (Durand, 1998b; Pérez and Durand, in press). Their action in this case has the archetypical characteristics illustrated in the following example, taken from a gymnastics lessons with 15-year-old students (Figure 3).

The teacher's action is cyclical and repetitive. Within the cycles, two sequences stand out clearly. The first is a standard "proactive" sequence during which the teacher addresses the entire class and gives instructions for the workshops. The second is a fluctuating and "interactive" sequence during which the teacher observes, advises individual students or groups, evaluates, and assists.

These sequences are called archetypes because they are produced frequently and regularly by many teachers, despite contextual variations

such as the type of student, the sport being taught, the equipment used, the teaching goals, and so on. The coordination of these two archetypical sequences defines the fundamental structure of this action. The basic interactive sequences are supported by complex dynamics that do not obey a simple deterministic law of causality (Gal-Petitfaux and Durand, submitted; Hauw and Durand, 1998).

3.2. Dynamic Organization of Interactive Sequences

Interactive sequences are subject to a great deal of variability. Two examples are presented here. The first is taken from a gymnastics lesson organized into work groups.

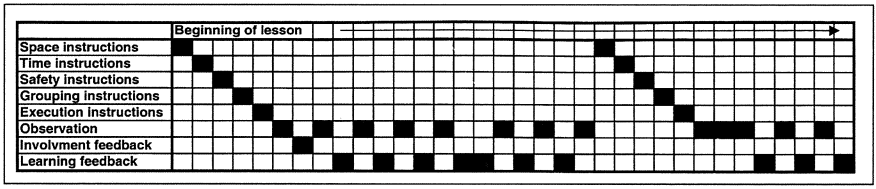

Figure 3. Cyclical and repetitive sequence of action units during a gymnastics lesson. The actions are carried out by the class (C), a student group (G), or a student (S).

In this sequence, the teacher stays next to the students, who are learning the forward handspring on the vault. His presence has two main functions: safety and guidance. The students line up and take turns vaulting at a rate of about one vault every 30 seconds, for the 20-minute duration of the workshop. This made a total of six trials per student, one every three minutes. Each vault was followed by a comment by the teacher, which was (i) a description of the movement performed, (ii) an evaluation, or (iii) execution instructions for the next trial. This feedback was classified into five categories on the basis of its content: arm extension, support phase, hand spread on vault, velocity, and concentration (Table 3).

Table 3 - Beginning of feedback sequence issued to students in the forward handspring workgroup and classification into five categories: concentration (C), arm extension (A), support phase (S), velocity (V), and hand spread (H).

Trial	Student	Feedback	Category
No.1	No.1	«Hey ... Stop acting like idiots you guys ....»	C
No.1	No.2	«No ... not like that ... stretch out your arms ...»	A
No.1	No.3	«Your shoulders are too far forward ...»	S
No.1	No.4	«Same for you Matthew ... your shoulders ...»	S
No.1	No.5	«Your shoulders, too far forward ...»	S
No.1	No.6	«Far in front ... so you won't bring your shoulders forward ...»	S
No.2	No.1	«Without pushing forward that won't do ...»	V
No.2	No.2	«A longtime in the trampoline, and resist ...»	V
No.2	No.3	«Pow ... you have to spurt off the trampoline ...»	V
No.2	No.4	«Extend you arms, Mr. Boris ...»	A
No.2	No.5	«Same for you Matthew ... your arms aren't stretched out ...»	A
No.2	No.6	«Your arms are bent ... this is no good ... look Alexander ...»	A
No.3	No.1	«Shoulders in front ... come on ...»	S
No.3	No.2	«Too far forward, your shoulders ... try to see about that ...»	S
No.3	No.3	«Stretch out your arms ... Jacob ...»	A
No.3	No.4	«Same ... arms extended...»	A
No.3	No.5	«Too far apart, your hands ... like this ... got to bring them together ...»	H
No.3	No.6	«Same thing ... it's dangerous with your hands spread apart ...»	H
...	...		...

Analyzed from the students' standpoint, the flow of feedback did not differ from a random sequence. Analyzed from the teacher's standpoint, it exhibited a number of regularities: each remark was associated with a probability equal to .24 of being produced in isolation, a probability of .44 of being produced in a series of two consecutive remarks from the same feedback category, a probability of .52 in a series of three, .12 in a series of four, and .04 in a series of five. The probability that a remark from a given feedback category would be produced was .81 if it was preceded by a single remark from the same category, .69 if preceded by two remarks from that category, .29 by three, and .25 by four.

This analysis points out the phenomenon of cognitive *hysteresis* (Norman, 1993), which refers to a person's tendency to adhere to a habitual or prior diagnostic (up to a certain threshold). This phenomenon was

accentuated here when the inter-trial interval was short: it averaged 26 seconds for consecutive feedback belonging to the same category and 33 seconds for feedback from different categories. This teacher is thus faced with a dilemma: if he goes faster to give the students more chance to practice, he increases the *hysteresis* phenomenon, and in doing so, reduces the effectiveness of the feedback and lowers the probability that learning will take place. When MEUs are concatenated, the contents of the preceding units contaminate the units that follow. In Peirce's terms, this means (i) that the product of the preceding sign (the verbal utterance) is an anchor point for the representamen of the following sign, (ii) that the production of feedback is governed by two rules, "reproduce the same theme" and "tell the student how to correct the wrongest part of his movement", and (iii) that there is a prototype (Rosch, 1978) that serves as a model for success, for the forward handspring : " propelling-repelling-tonicity-concentration". The relative forces of these components is a function of the current state of the system: the force of the first decreases as more and more feedback is given, and the force of the second increases. The system is highly stable and the feedback is predictable when the force of one rule is high and the other is low; it is unstable and the feedback is unpredictable when the force of both rules is intermediate. The action in this case is more highly anchored in perceived events and the teacher takes the salient aspects of the situation into account. His perceptual judgments are confined to the usual interpretant of "a good forward handspring". Globally, the system is stable at this point, and the sequence is predictable: the mean observed probability of each piece of feedback issued is .63 whereas the probability calculated from the random distribution hypothesis is .44.

The second example is a table tennis lesson with 18-year-old students. The teacher gives the following instructions: "You are going to learn how to earn a point. To do so, try to play where your opponent is not, forcing him to move: if he's on the left play on the right, if he's on the right play on the left, if he's close to the table make a long shot, if he's far make a short shot". The students break up into pairs and the teacher walks around among the tables making sporadic comments. The underlying organization of this sequence can be illustrated by separating the student's and teacher's respective actions (Table 4).

Table 4 - Evolution over time (a span of about two minutes) of a student's intended play, and feedback given by teacher to different students during a table tennis class.

	Student	Teacher
Time 1	Alternate regularly between right and left shots	«On the left if he's on the right and on the right if he's on the left»
Time 2	Alternate regularly between short and long shots	«Yes but you, you have to get it back in there too, and fast»
Time 3	Alternate regularly between short and long shots	«Look carefully at where your opponent is in order to choose your shot»
Time 4	Always cross shot	«Too late, you have to try to anticipate, guess where the ball will go»
Time 5	Alternate between long right shot and short back-hand shot	«Your legs are too stiff, bend your knees»
Time 6	Alternate between long right shot and short back-hand shot	«That return was a catastrophe: you have to slice the ball, like this» (gesture)
Time 7	Alternate between long right not-crossed shot and short crossed return	«You have to sense whether you're the offense or the defense»
...	...	...

At first, the student's intentions were close to the teacher's instructions. But as the student made more and more shots and the opponent returned them, his tactics started to deviate from the instructions and ended up taking on a form that did not even consider the opponent's position (for methodological reasons, this phenomenon was analyzed for one student only, but in all likelihood, it occurred for other members of the class too). At first, the teacher's remarks were in line with his initial instructions, but they gradually moved away until they differed totally ("sensing who has the upper hand in the game").

The student's and teacher's actions are constructed step by step, depending on the opportunities offered by the sequence of events. The dynamics are accentuated by the discontinuity and repetitiveness of the action of returning the ball in table tennis, which favors this kind of on-

line revision of the player's intentions. The evolution of the student's actions reflects a more or less systematic searching or learning strategy (Newell, Kugler, Van Emmerik, and McDonald, 1989). It is an optimization strategy in a non-uniform action space (Gel'fan and Tetslin, 1972). The teacher's action has a dual anchoring: his initial pedagogical intention, and the scene in front of his eyes (which depends on the students' searching strategies). The classical phenomenon of disregarding or adjusting one's initial intentions in the course of action is amplified here by the fact that the events are determined collectively. Collective action in a classroom takes on the form of phases of convergence and divergence that alternate with variable regularity.

4. CONCLUSION

The action of a physical education teacher takes place within the time and space it defines and delineates. It is a continuum along which elementary units with unique complex meanings can be isolated. The connections between the units are generated in various ways by concatenating sets of archetypical sequences, the most basic structures of teaching. Complex instructional formats emerge from local interactions between the different elements in the system: students, teacher, space, time, equipment, materials, etc. The teacher's involvement fluctuates from one instant to the next, and is more or less closely tied to class events. The teacher's action remains viable, thanks to its self-organizing properties. But teacher-student cooperation is constantly threatened, precisely because of the dynamic nature of the actions of both the teacher and the students.

This general overview should serve as a basis for the development of future research in two areas. The first concerns the action of the students, which can be approached as a situated action (Anderson, Reder, and Simon, 1996; Brown, Collins, and Duguid, 1989; Ennis, 1992; Kirk and McDonald, 1998; Lave, 1988; Lave and Wenger, 1991). The second, which makes use of the concepts of distributed or collective intelligence (Hutchins, 1991; Resnick, 1991) and collective action (Hutchins, 1995; Lacoste, 1993), views a physical education class as a collective action that grows out of local interactions and should therefore be analyzed in terms of the system formed by the class, understood as a cognitive system.

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