GESTURES AND STYLES OF COMMUNICATION: ARE THEY INTERTWINED?

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The resources used by mathematics teachers include gestures, drawings and extra-linguistic modes of expressions, which can be analysed through a semiotic frame. Teacher's words may go with his gestures, his written signs on the blackboard or slides projection on a screen. Depending on the emphasis given to one among these three possibilities, the styles of communication could be classified into three main trends, where the body of the speaker, the speech and the blackboard play different roles with respect to each tendency. Gestures and styles of communication seem to be intertwined, since giving importance to the body or the written signs leads to different communicative styles; conversely, the style of communication influences the type, the frequency and the role of gestures/written signs accompanying the speech.

Key-words: teacher, gesture, communication, multimodality, semiotic bundle.

INTRODUCTION

This paper focuses on teacher's use of gestures, drawings and extra-linguistic forms of expression when talking about mathematical subjects. It investigates whether it is possible to define a relation between teacher's modes of using gestures and his style of communication. An answer is given trough a case study. Moreover, in the same case study possible effects on students' learning process are shown.

Different resources, spreading from words to gestures to ICT instruments, are employed by teachers in the class. Sometimes they become communicative tools, supporting students in their comprehension and learning process. A semiotic approach to teaching-learning processes in mathematics is useful to understand the personal appropriation of signs by persons within their social contexts (Arzarello, Paola, Robutti & Sabena, in print).

At a more or less deep conscious level, any teacher formulates his communication strategy. An analysis of communication strategies chosen by teachers is useful to understand the way mathematical concepts are told to the students. Specifically, it can be interesting to focus on the *objectives* of the message (in the case of mathematical lessons they mainly concern giving information and knowledge), on the *target* to which the lesson is managed; and on the *definition* of messages.

It can be fascinating to combine both semiotic and communication approaches, when examining the acquisition of knowledge by students. In this paper teachers' way of communicating mathematical concepts is considered. How they use gestures, what gestures they make, and which tools support their lesson, is taken into account.

This paper is divided into five main parts, this *Introduction* and a conclusion. *Section 1* focuses on the semiotic bundle, introduced by Arzarello (2006), who adopts a Vygotskian approach and presents an enlarged notion of semiotic system, which reveals particularly helpful for framing all the semiotic resources found in the learning processes in mathematics. *Section 2* is centred on communication strategies (Di Raco, 2000) adopted by teachers. Considering a mathematical lesson, common features and a classification based on styles of communication is presented. *Section 3* presents the methodology used in the case study. In *Section 4* the analysis of some videos is sketched and the main traits of different styles of communication are modelled on both bases of semiotic bundle and of communication strategies. *Section 5* reports some considerations about the relation between teacher's communicative choice and its impact on students' feelings. The *Conclusion* closes the paper.

THE SEMIOTIC CONTEXT OF SIGNS

In a semiotic approach to mathematical teaching, the role of signs and the way they are adopted by individuals within their social context is central (Arzarello, Ferrara, Paola & Robutti, 2005). According to Peirce, a sign is anything that "stands to somebody for something in some respect or capacity" (Peirce, 1931-1958). Within this wide perspective, Arzarello (2006) has introduced the semiotic bundle, which allows studying gestures – and teaching-learning processes – in a multimodal approach. Recent discoveries in neuropsychology (Gallese & Lakoff, 2005) underline the embodied aspects of cognition and show that the brain's sensory-motor system is multimodal rather than modular. Multimodality consists in interactions among the different registers within a unique integrated system, composed by different modalities: gestures, oral and written language, symbols, and so on (Arzarello & Edwards, 2005 and Robutti, 2005).

An important example of semiotic bundle is given by the unity speech-gesture. McNeill claimed that gesture and spoken utterance should be regarded as different sides of a single underlying mental process (McNeill, 1992). Gesture and language constitute a semiotic bundle, made of two deeply intertwined semiotic sets. Researches on gestures have discovered some important relationships between the two, for example match and mismatch has been studied (Goldin-Meadow 2003).

The term "gesture" includes a variety of behaviours that do not form a single category. According to McNeill, the term designates any spontaneous movement of the hands and harms that people perform when talking. Gestures are characterized by the following features (McNeill, 1992): they begin from a position of rest (the *preparatory phase*), move away from this position (the *peak*), and then return to rest (the *recovery phase*).

McNeill (1992) identifies two types of gestures: the *propositional gestures*, which have a main pictorial component, and the *non-propositional gestures*, which are discourse gestures. The propositional gestures could be *iconic gestures*, if they bear a relation of resemblance to the semantic content of discourse; *metaphoric gestures*,

similar to iconic ones, but with the pictorial content presenting an abstract idea that has no physical form; *deictic gestures*, if they indicate objects, events or locations in the concrete world. Among the non-propositional gestures, McNeill distinguishes the *beats* (e.g. the hands move along with the rhythmical pulsation of speech, lending a temporal or emphatic structure to communication), and the *cohesive gestures*, that tie together thematically related but temporally separated parts of the discourse.

Since recent findings in psychology show that gestures can contribute to creating ideas (Goldin-Meadow, 2003), investigating how gestures are used by the teacher can be useful. In fact, it has been shown that – when gestures accompany the discourse – the listener retains more information with respect to a situation in which no gestures are performed (Cutica & Bucciarelli, 2003).

The types, the frequency and the use of gestures vary not only from teacher to teacher, but also depend on the choice of supporting tools like the blackboard or the slide projector, during the lesson (Andrà, in print).

STRATEGIES OF COMMUNICATION

Semiotic activities are classically defined as communicative actions utilizing signs. This involves both sign reception and comprehension via listening and reading, and sign production via speaking and writing. In researches of the Turin group (Robutti, 2006), it has been investigated both the role of gestures and written signs in the mathematical discourses of students, and the role of teachers' gestures with respect to the learning processes of students: how they are shared among students and how they influence their conceptualisation processes (Furinghetti & Paola, 2003).

In order to analyze the phases that a teacher follows to prepare a lecture, the classification used by Di Raco (2000) is adopted. The first phase is the phase of *knowing*, which consists of defining theoretical objectives, choosing communication policy and investigating about expectancies and needs of the target to which he refers; in this phase, the teacher get conscious of the teaching-learning situation in which he is involved.

The phase of *designing* consists in modifying theoretical objectives and adapting them to the target, creating events and communicative situations, selecting communication channels and identifying tools that can help the teacher to talk as more clearly as possible. In this phase the teacher chooses tools that can support him while teaching (the blackboard or the slide projector).

The phase of *planning* consists in defining lengths of time, resources, structure and style of the communicative activity.

The phase of *implementing*: it is the only part that the researcher can analyse when watching videos (as it is the case of this paper), and by this examination it is possible to know something about the previous phases.

METHODOLOGY

The case study focuses on teacher's use of gestures, drawings and extra-linguistic forms of expression when talking about mathematical subjects. Defining a relation between teacher's modes of using gestures and his style of communication is the purpose. Only university lectures have been chosen for the analysis, in order to avoid any noise given by lack of discipline from students.

In a first step, seven videos have been analysed: they concern university lessons on mathematical subjects and each one lasts about 30 minutes. They have been examined from both the semiotic context and the communicative strategies perspectives. Contributes from communication strategy researches supply a background for the semiotic analysis that is the core of this paper. The results of the analysis in the first step are reported in the next section.

In a second step, six new lectures (speakers are labelled respectively F, G, H, I, L, M) had been analysed, following the classification defined in the first step. At the end of each lesson, a questionnaire was given to students, in order to have an immediate feedback on their feelings. The questionnaire was structured in four parts: the first one contains a series of couples of opposite adjectives describing the teacher's attitude (the students and the teacher were asked to agree at a certain level to one between the two adjectives of each couple); in the second part an opinion about the rhythm of the lesson was requested; the third part was focused on students' perception of understanding: how they take notes, whether or not they remember previous lessons and what was the subject of the lecture. In the last part, an opinion about teacher's gestures was asked. A similar questionnaire was given to each speaker, in order to have the possibility of comparing the teacher's intentions whit the student's receptions. The number of students involved in answering the questionnaire is 178: 35 students in lecture F, 18 in G, 70 in H, 26 in I, 24 in L and 5 in M.

GESTURES AND COMMUNICATION STYLES

From a semiotic perspective, it is possible to distinguish four phases in each lecture. In fact, the semiotic unity speech-gesture evolves in time. Each phase corresponds to a particular relation between words and use of signs, gestures, drawings and so on.

The *"zero" phase* consists of the first few minutes: the speaker ties with his audience. In this phase, either the speaker does not gesticulate, or his gestures have few relevance. The *introductory phase* is characterized by a great number of gestures: during this phase the teacher introduces the language that becomes shared between him and his audience. The strong relation between speech and gestures is evident. The *main phase* is more extended temporally than the previous one, but is characterized by a decreasing number of signs. In fact, the teacher has already introduced the main concepts he needs and the words he uses evoke themselves the ones – combined with signs – he has utilized in the previous phase. Some signs, utilized in the introductory period, are utilized again. The *concluding phase* varies from teacher to teacher, but a common feature is that an increasing frequency of signs

is observed. A possible explanation could be that in this phase there is the need of fixing the concepts firstly introduced and then explained in the previous phases.

On the side of communication strategies, all videos have in common some main features. In fact, the objectives are mostly cognitive and didactical ones (transmitting knowledge is at the core of the activity); the professor speaks neither to equals nor to a generic public: the target is a group of professionals with a lower level of knowledge; messages he communicates are mathematical contents; and channels of communication consist always in front lessons.

There are some differences, from speaker to speaker, in communication policies and in tools accompanying talks (slides projection, blackboard...). Focusing on the semiotic bundle speech-gesture leads to consider also such supports the teacher may use. The role of such instruments is crucial. The choice of the communication policy influences not only the quantity and the quality of signs but also the preference for certain tools accompanying talk, instead of other ones.

Referring to these choices, in analysed videos it is possible to distinguish three distinct trends. When the communication takes place mainly through *the body* of the speaker, iconic and metaphoric gestures are predominant, because it is the same body of the teacher that talks with the audience. In the speech-gesture unity, the second component has a central role. The use of the blackboard or slide projection is limited or it is absent. Among non-propositional gestures, beats are numerous. In the “zero” phase the teacher does not make signs nor gestures. The introductory phase is characterized by a great number of iconic and metaphoric gestures, and some signs are pictured on the blackboard. The strong relation between words and gestures is clear and it reveals its potential power. Gestures used in this phase are repeated in the subsequent phase. The speaker is introducing the lecture and the concepts he is talking about will return during his speech in the next phase. He will broaden these concepts, and gestures utilized at this time would be repeated, going with words as an inseparable unity. During the main phase the creation of iconic and metaphoric gestures falls off, while the number of beats holds steady. Some iconic and metaphoric gestures of the previous phase are utilized. At times cohesive signs are used, for example to connect what the teacher is telling to what had been written on the blackboard. Signs written on the blackboard are not erased and accompany the whole speech. Written signs enrich the semiotic bundle made of words and gestures. In the last phase gestures utilized during the introductory one get back.

In the second trend observed in those videos, the communication takes place mainly through *the blackboard*, i.e. trough written signs that are contemporary of speech. The unity speech-written sign is central in the semiotic bundle, and gestures serve to enrich it. Deictic and cohesive gestures are dominant. In the “zero” phase the blackboard is already at the centre of attention, because the speaker is writing on it or because he just points it (e.g. no sign has already been made, but the speaker indicates, while he is introducing concepts, the point where he will start to write few

minutes later). The introductory phase is characterized by the use of the blackboard. Cohesive and deictic gestures as well as beats are frequent. At the beginning of the central phase the blackboard is erased. It is continuously utilized and it is erased many times. In the final phase the blackboard is employed in a manner that is, in some way, symmetric with respect to the introductory phase.

In the last tendency identified, the communication happens substantially trough the projection of slides. In this case the signs produced by the speaker are very limited in number. Iconic and metaphoric gestures are absent. Beats are slightly incisive. It is hard to distinguish the phases shown for the previous trends. The semiotic bundle is made mainly of words and of signs projected on the screen.

The reader is referred to Andrà (in print) for an exhaustive analysis of those seven videos.

IMPACT ON STUDENTS

It has been shown that it is possible to piece together theoretical aspects belonging to the semiotic context and to strategies of communication. The result of this mix is a framework in which one can analyse a didactical activity such as a lecture from a more complex point of view. Four different phases in the teacher's speech have been distinguished. These phases are characterized by aspects referring to both gesture studies and to communication techniques. Different styles of communication involve different uses of signs, in quality and in quantity. And how a speaker uses his body rather than other didactical tools such as the blackboard determines different strategies for the communication of mathematical concepts.

The question of interest is now about the effect of each strategy on students' feeling. Till now, the semiotic analysis of gestures has focused only on the teacher. The teacher, however, communicates to students. Students are listening to him, they are learning the concepts he teaches. Following Vygotsky (1986), how do the choices he has made influence the way students internalize what he has said?

According with the analysis from the six new lectures and the questionnaire, two professors (F and G) followed the first communication strategy: their body plays a central role when they speak. I, L and M followed the second communication strategy: the blackboard was the main tool to teach. Speaker H used slide projections in conducting her lesson. In tables 1, 2 and 3 the main trends in students' answers are reported. When the proportion of students choosing a certain response is lower than ¼, it is not reported, since it has revealed as little significant.

In table 1 the six couples of opposite adjectives describing the teacher's attitude are shown. For each couple, the major trend is indicated for each teacher's style (the students' proportion of the main trend is given). Looking at table 1, when in the unity speech-gesture the second component (i.e. the body) prevails, students' perception is mainly in involvement. Students feel them near to the teacher's world. If the blackboard plays a central role, this involvement is a little lost and it is not perceived

when the blackboard is replaced by the slide projections. In this last case, students' perception of conciseness and of a schematic presentation increases with respect to the other two cases.

	F (body)	G (body)	H (slides)	I (blackb.)	L (blackb.)	M (blackb.)
Interesting Boring	80% appealing		60% quite boring	60% appealing		
Involving Detaching	70% involving		60% detaching	50% involving		
Concise Lengthy	> 50% lengthy		60% concise	50% quite lengthy		
Schematic Convoluted	>50% quite convoluted		80% schematic	50% quite convoluted		
Clear Confused	60% sufficiently clear		50% clear	60% in the middle		
Passionate Cool	80% passionate		70% quite cool	50% passionate		

Table 1: Main trends (percentages) in judging teachers' attitude are compared

The opinion on the rhythm of the lesson varies from one strategy to another. How students perceive the speed of the lesson may reveal how quickly they interiorize concepts explained. If the rhythm is suitable or slow for a student, probably he finds little difficulty in understanding what the teacher is saying.

	F (body)	G (body)	H (slides)	I (blackb.)	L (blackb.)	M (blackb.)
Teacher's rhythm	45% suitable 45% quite fast		25% slow 25% suitable 35% fast	30% slow 30% suitable 30% fast		

Table 2: Main trends (percentages) in judging teachers' rhythm are compared

Table 3 reports the main trends in students' perception of understanding. The body-style had lead to a broaden spread of key-concepts perception. In the slide case, on the contrary, the key-concept is definitively perceived by a larger percentage of students. A possible interpretation is that grasping mathematical knowledge seems to be easier when slide projections are employed, rather than when the teacher speaks with no support like this.

	F (body)	G (body)	H (slides)	I (blackb.)	L (blackb.)	M (blackb.)
Notes?	100% often		50% only displayed	60% often		
Previous lessons?	70% remember		30% don't remember 30% remember 30% know where in the program this lecture is	50% remember 20% know at what point in the program this lecture is		
The subject of this lecture?	50% skin-deep concepts		70% quite good understanding	30% quite deep 40% superficial		

Table 3: Taking notes, remembering previous lessons and understanding the analysed lecture are shown by comparing the main trends

Finally, an opinion on teacher's gestures was asked. Students had to indicate whether the teacher had made signs during his lesson and whether these gestures were bothersome. The purpose was of knowing students' perception of gestures and words as a unitary entity: if students did not notice teachers acts, movements or signs, one can hypothesize that gestures are felt as intertwined with the speech.

In the body-centred case, iconic and metaphoric gestures are heavily utilized, but a percentage of 20% of students had never noted them, an analogous percentage said that the teacher wrote on the blackboard mostly and only a half of students realized that the speaker made gestures, and they were not bothersome.

In the blackboard-centred case, only 5% of students said that the teacher wrote mostly on the blackboard, 40% said that he did not make signs or that it had never been noticed and 60% that the speaker gesticulated mainly.

In the slide-centred case, 45% of students said that the teacher gesticulated but it was not bothersome, 40% said that they had never noticed it and 15% that the speaker did not make signs.

It seems that the main tool chosen by the professor in communicating has not been noticed: students' attention is driven on the other supports (on the blackboard in the body-centred lessons, or the body in the blackboard-centred ones). One can suppose that the main tool (the body, the blackboard and the slides respectively) has been perceived by the students as an underlying entity, which forms a semiotic unit with the speech. Conversely, students noted that the teacher has been using different tools, those tools he did not concentrate on.

CONCLUSION

Both semiotic standpoint and researches on communicative strategies can help to frame teacher's way to conduct his lesson. It has been shown that types, frequency

and the use of gestures are closely related to the style of communication chosen by the speaker. The impact of each strategy on students learning process has been analysed from four distinct perspectives: how the teacher's attitude has been perceived by students, how the rhythm of the lesson has been felt, what level of perception of understanding students had and how teacher's gestures had been noticed.

Students seem to be mostly involved in the case the professor used mainly his body when speaking. When the blackboard plays a central role, a little lost of such involvement has been observed and, when the blackboard is replaced by the slide projections, it has not significantly perceived. In the slides case, conciseness and precision have been more perceived, rather than in the other two cases.

When the teacher used his body to communicate, students often take notes and are able to remember the previous lecture. When the slides were utilized, the notes taken are less, because they wrote only fundamental concepts, but a greater percentage of students was able to indicate in which part of the program the lesson was located.

If the blackboard is heavily used, further investigation is needed. It is not clear neither if students remember the subject of the previous lesson, nor how they take notes. Their level of understanding is not evident. A possible interpretation of this fact is that the use of the blackboard assumes all the students be able to capture the concepts at the same speed, namely the speed of the teacher's writing.

As a final consideration, it has to be pointed out that students reversed the rule between the main and the accessory tools chosen by the teacher. For example, they had said that teacher F mainly wrote on the blackboard while he had primarily used his body, but whit a regular pacing on the blackboard: in the introductory phase he wrote the concepts he recalled at the end of the lecture, without erasing them. The main tool is perceived as integrated with the speech. The rhythm of the lecture is beaten by the use of this tool (e.g. the body). Students noticed a change in the rhythm (associated to a change in the tool used, for example from gestures to the blackboard), rather than the smooth use of the main tool. Accessory tools became central in their perception, since they corresponded to a change in the rhythm of the lecture.

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