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THE ROLE OF EMOTIONS AS TRANSMITTED BY THE USE OF CARTOONS AND GAMES IN CONSTRUCTING MILIEU IN NEGOTIATING MATHEMATICAL KNOWLEDGE IN PRIMARY AND LOWER SECONDARY SCHOOLS[1]

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ABSTRACT

In this research I have studied the teaching/learning processes in lower secondary schools, with the aim of constructing particular teaching environments (milieu) and refining particular 'tools or attitudes', which the teacher can use in order to improve the understanding of mathematical topics. Considering that 'school learning operates by transforming conceptual thought' (Vigotskij, 1966), the teacher's activity is connected to a logical perception, which is characteristic for each and every learner. Indeed, every pupil is endowed with 'simple' and 'elementary' ideas which characterise the initial phase of learning. My ideas about teaching emphasizes places attention not only the teaching phase but also the possible repercussions in the learning phase. The specific use of cartoons and of a game and particular tools or teachers' attitudes in our experimentation are favourable in mediating and negotiating mathematical meaning in class. The word 'attitude' indicates the totality of all those gestures, words and fictitious strategies which the teacher can knowingly use in introducing various mathematical aims into a particular atmosphere, one which emotionally involves the learner. An important aspect in communicating a mathematical aim will be to encourage the learner to take into consideration the problem proposed as their personal problem (devolution), to be able to identify mathematical tools in resolving problems. The study of teaching activities has been dealt from many points of view:

- *the dynamics of interaction between problem situations and the learner, teacher-learner, or between the learners themselves*
- *the use of the teacher's attitudes and precise tools with which to mediate and negotiate meaning*
- *the learner's behaviour and the teacher's teaching strategies.*

I also wondered what effectively the role of emotions in learning is and if it would be possible to use emotions not by 'imposing' knowledge but by encouraging learning to become a 'wish to learn' (apetitus noscendi, Changeux, 2003).

AIM OF THE WORK

The context or environment has an essential function in negotiating meaning as means of communication in the teaching system. The use of various linguistic registers and personal, cultural experience are important elements in encouraging communication. Vygotskij has drawn on Piaget's assertion: "Being aware of an operation indeed means passing from an action to a linguistic plan; it means, therefore, inventing it in your imagination, to be able to express it in words" (Vygotskij, 1990, p.227). Clearly, in order to pass from one to the other, the action must be contextualised and then recognised and accepted by the learner. In order for understand and encourage the process of passing from an action to a linguistic plan in the teaching process, the connection between the 'word and its meaning' must be taken into consideration; this is not stable but subject to a process of evolution (Vygotskij, 1990, Chap VIII).
My objective is to study the acceptance of this devolution, connecting it to affective learning in order to emphasise the tie between the word and image and their meaning to the learner. This takes place between the meaning of the term in its internal language, common language (that is, everyday extra-curricular experience) and the specific meaning of mathematical terms.
The *working hypotheses* strictly connected with my research hypothesis are:

[1] Doctoral Thesis, University of Bratislava (Slovak Republic), 2006, Advisor: Prof. Filippo Spagnolo.

H1: Constructing teaching situations, involving a conscious use of cartoons (or of arithmetic games) to facilitate devolution.
H2: Constructing learning/teaching milieu which encourage an instrumental use of functional emotions as regards mathematical knowledge (from the learner's and teacher's point of view).

THEORETICAL FRAMEWORK

In my experimentation, I have created 4 cartoons and I have used 'Guess the Number' game. One of the theoretical reference models in both cases is **Guy Brousseau's Situation Theory**, which is present in the choice of methodology in creating the situation/problem.
A theoretical reference for analysing the teaching situation and learners' behaviour during the game (in addition to those of semiotic, epistemological, psychological and historical enquiry) is that of **neuroscience** (J. Pierre Changuex, 1998 e 2003; Antonio Damasio, 1995; Gerald Edelman, 1987). In both experimentations the a-didactic situation is based on a game and it was very interesting to study the parts of the brain, which are concerned with analysing effective learning with a game-like activity. Analysing the a-didactic situation with reference to mathematical cartoons takes into consideration the use of specific graphic tools, used in creating cartoons, which seem to facilitate mathematical communication. These tools are used in attempting to recreate an environment which is familiar and easily recognisable by the learners.

MAIN IDEA OF THE REPORT

The choice of carrying out experimental research which includes games or cartoons does not arise only from the necessity of investigating concepts about learners, rather from the need to suggest a new way of 'doing' mathematics, which appeals to a motivational state as regards personal needs. Various objectives have guided me in the selection of teaching tools which are to be used in structuring my experimentation. Some of these are:

- studying multi-sensorial aspects in teaching and learning activities for mathematics
- analysing the game-like characteristics of mathematics in relation to the motivation and interest of doing this type of mathematical activity (*appetitus noscendi*, Changuex, 2003)
- developing a real sensitivity in the learners in interpreting and comprehending symbolic images
- organising a grammar which is the most characteristic possible in creating and interpreting a mathematical cartoon
- analysing, from a neuro-physiological point of view, the use of parallel and serial thought by means of diagrams
- analysing the role and meaning of the graphic tools, used in creating cartoons, for students which are recognised by the cartoon's iconic code or those which have been introduced *ad hoc* by the teacher (the teacher's implicit tools)
- analysing the problem of mathematical communication in multi-cultural environments.

Regarding the 'Guess the number' game, my objectives are

- thoroughly analysing the relationship between natural and symbolic language
- analysing how the constructing of patterns intervenes in the process of anticipation

METHODOLOGY

The experimentation was carried out in 3 classes in 2 secondary schools in Palermo (Italy) and two classes in Ficarazzi, a village near Palermo. The students were from between 10 - 13 years old.
The *guessing game 'Guess the number'* was analysed and subdivided into specific phases when used as a teaching tool for negotiating between arithmetic and pre-algebraic meanings, and the iconic role of symbols. With this activity the passing from arithmetic and pre-algebraic language was analysed by starting

with the problem, which uses a purely natural language. With the aim of making a model of researcher-teacher activity, the activity is organised in the following way:

- *initial ai*m: to solve the problem
- *condition which justifies modelling:* not knowing how to solve the problem
- *discursive phase:* the teacher listens to individual learners' comments and ideas
- *translation phase:* the teacher translates the problem described in natural language into mathematical symbols and then begins to reread it and reflect on the above
- *a mathematical model is created and the problem of this model is reread:* in this way the use of mathematical tools for solving the problem is highlighted
- *the mathematical problem in the model is solved*
- *go back to comment on the solution of the real problem*

In our *experimentation the use of cartoons*, instead is to verify and check the notions acquired or present in a class but their use is also provided for when introducing new, mathematical concepts.

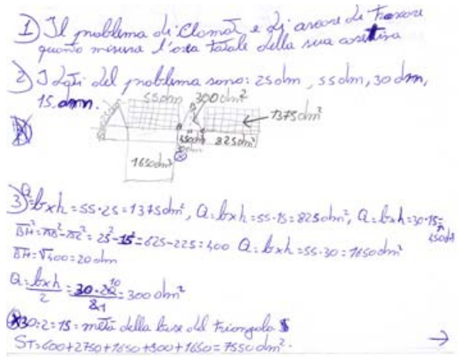
Four cartoons were deployed in the experimentation, being organized according to the various teaching topics. The main character to be found in these activities is Clamat, a friendly mouse. A teaching unit was prepared for each cartoon thus: The problem of the pots, The problem of the ladders, The problem of the roads, The problem of the house. One of the key aims of Clamat's cartoon is to provide a framework within which students can establish relationships and meaning, similar to an index system in a library. This allows concepts to be filed away in compartments in the memory, thereby making their retrieval much easier. Much information can be contained within a small space and the ideas can be arranged in such a way so as to identify relationships between concepts and encourage thinking from a larger perspective.

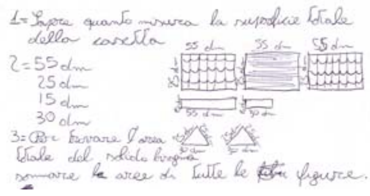
Within a neuro-physiological and Vygotskian perspective, the teacher's role is fundamental as the mediator of this process. By creating or choosing appropriate designs and suitable contexts, they must try to stimulate interest and encourage social interaction. Indeed through these activities, children record many experiences of movement in which their 'cognitive unconscious' (*Lakoff & Nùñez, 2000*) is recalled, updated and made explicit. Regarding the multi-sensorial use of cartoons as linguistic mediators, the approach to reality is fundamentally far from being a simple connection between scholastic learning and everyday experience. In accordance with neuro-physiological studies, the recent theory of Embodied Mathematics (*Lakoff & Nùñez, 2000*) and the results obtained from my experimentation, I have sought to understand how certain scientific knowledge within the learners' minds is constituted, considering that mathematical concepts, logical structures and tools used are the basis of a real bodily experience (in the case of cartoons, it is 'virtual').

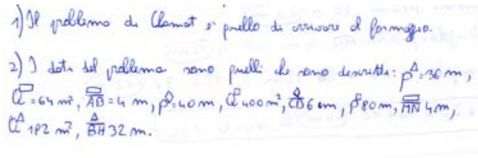
AN EXAMPLE OF DIDACTIC SITUATION

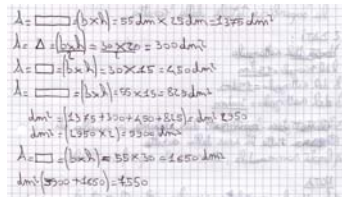
The use of a cartoons-activity can be introduced by demonstrating one of Clamat's cartoons to the class. The learners receive two photocopies: one with the cartoon strip and the other a guided questionnaire. For example, The problem of the house is the following cartoon:

This cartoon was given to the highest classes in the lower secondary school to reinforce the concept of the expansion of a solid. 'The problem of the house' deals with the following: "Clamat is painting his house and he need to know the extent of the surface to be painted. In combination with the 'question of mark', Clamat's facial expression tells us that he has a problem. Our attention is then transferred around the character, trying to make sense of the image. This context was immediately recognised by all the students, some of whom spontaneously recognised Clamat's problem, referring to it at home. The use of colours was one way of helping learners who did not understood the concept of the 'expansion' of a solid very well. Whilst commenting on the images, many of the learners could help themselves by understanding the significance of the colours used. Below are some examples of the learners' work:









During the activity, in fact, the teacher asks the learners to answer the following guided questionnaire:

1. What is Clamat's problem?
2. What are the data in the problem?
3. What strategies could Clamat use in resolving the problem?
4. Why have you chosen these strategies?
5. What does the message in the balloons mean?
6. What do the arrows represent?

In general, the answers of the pupils about the questions 5 and 6 regarding the balloons, were:

- the balloon cannot be removed because it says how many pots of paint are needed to paint two lengths of wood;
- they are necessary in understanding the data for doing calculations;
- the balloon helps me to think about the problem;
- the balloon summarizes the problem;
- the balloon is related to the mind, ie. Clamat's problem;
- the balloon gives us the data for the problem;
- the balloon suggests that Clamat will shortly eat the cheese;
- the balloon suggests that Clamat should concentrate on taking the cheese;
- the balloon shows what Clamat thinks the house is made of.

Regarding the arrows

- the arrows show that one pot of paint will cover two lengths of wood;
- they mean: 'correspond to';
- the arrows replace the 'equal' sign;
- the arrows show how the house is, once it has been opened up in all its parts;
- the arrows show the house in pieces;
- the arrows indicate the passage between the closed house and the opened up house.

Moreover, it was observed that the least interested and weakest learners participated in the activity. The teacher is not present as a "teacher" but as a supervisor. The teacher gives the comics and a set of questions to the pupils and then he must supervises the development of the production of single pupil. In the lesson-exercise he must give birth the interpretation of the problem from the polyphonic interlacing between the story that the iconic images tell.

Regards the *guessing game 'Guess the number'* I have considered the following four teaching points: after having created a problem, using the most natural language possible, the teacher should

- **justify the linguistic and literal translation** in the formulation of a problem, passing from a natural to mathematical language
- **initiate** the translation, motivating each single learner to model the problem in their own way in mathematical terms
- **explain** the fact that the translation is from a natural to a mathematical language, thus keeping separate the natural from the mathematical world and thereby helping the learners to understand when they are a part of one or the other
- **lead** the learners to a meta-cognitive reflection about the problem, encouraging its generalisation.

So, after having subdivided the learners into groups, the teacher explained that the aim of the game was to work out how a pupil (who knows the game) could guess a number thought of by the other players, who then received the following information:

- 1st phase: the pupil addresses each group of learners, with pen and paper, and asks them to think of a number and remember it, without communicating it
- 2nd phase: the pupil addresses all the groups, asking them to apply the instructions (on the board) to their number and remember the result (1st instruction of the game[2])
- 3rd phase: the pupil asks the first group to communicate their result and writes it on the board under the first instruction. Then, the pupil asks for the results from all the groups and these are written next to previous result.
- 4th phase: the pupil writes (quickly) the numbers which each group had thought of under each result and asks the learners to work out how it was done
- 5th phase: the pupil listens and asks the groups to talk amongst themselves; each group tries to be the first to solve the problem (20 minutes)
- 6th phase: before writing the 2nd instruction, the pupil will begin a literal translation phase into the symbols of the instructions in the text, necessitating this due to a lack of board space
- 7th phase: at this point the pupil will write the 2nd instruction under the 1st (the latter written in symbols) and invite the learners to think of another number and apply the instructions, communicating the result

[2] Instruction no.1: multiply the number thought of by 5; add 6; multiply this sum by 4; add 9 to the total; multiply the final number by 5; write down the result.

-the pupil will quickly write the number thought of by the learners under each result
-the communication phase with groups of learners (15 mins) follows then writing on the board possible new strategies and/or falsifying the previous ones

- 8th phase: needing more space on the board to write the 3rd instruction, the pupil begins translating the symbols of the 2nd instruction, which will be written under the 1st instruction
- 9th phase: the pupil gives the 3rd instruction to the learners, this time having the whole class play in groups against the pupil. Then the pupil thinks of more numbers (4 or 5 numbers in particular containing a negative number and 0) and communicates the results.
- 10th phase: in the final phase, the pupil will compare the possible strategies and, after some discussion phase for analysing the validity of the strategies, will communicate the pupil's own solving strategies (unless a group has not already understood and used the strategies).
- 11th phase: the learners are asked to invent an instruction and play amongst themselves.

The validation phase: one of the interesting results was the problem of time. The pupil could not function as a walking calculator and needed time to perform the calculations. This clashed with what they had seen and the answers were given in a short period of time, almost instantaneously.
From a qualitative analysis it emerges that the following objectives have been encourage:

1) increasing the importance of the sign '='; 2) reflecting about the importance and potential of a 'formula' concept; 3) reflecting about the falsification of symbols as a tool which enables: i) the passing from a more articulated problem to an easier one; ii) more problems to be solved in less time; 4) increasing the importance of the translation phase into mathematical symbols and passing from a natural to a mathematical language; 5) the importance in using symbols for abstraction and reflecting on the use of brackets.

CONCLUSION

My experimentation has shown that learning can be integrated into the mathematical subject to be described, thanks to a strong emotional connotation and motivation, which is turn is bound up with the learner's will to continue playing and win by having fun. My experimentations has helped me to verify that the mental processes and perceptive mechanisms are not spontaneous and natural at all but they must be decoded, the competence of which depends on various educational and cultural variables. Emotions are indispensable for creating a memory because they organise the memory into a sequence of events. We can hope that the mathematical message transmitted by a real situation-problem, in a cartoon or created by the teacher in a game, is the same for each learner. Each learner must be able to recognise the context and know how to move inside of it. My results are:

- The teacher used tools (attitudes, words, gestures, icons, boardwork) in the game and cartoons, both of which contributed to developing and understanding various specific concepts in the teaching aim.
- Regarding the 'Guess the number' game, the board is a very powerful tool of mediation for the teacher since, if well analysed, it leads to a conscious and critical reflection about the use of mathematical tools and the generalisation of analysable problems by using a formula.
- Discursive processes (developed throughout the validation phase) had a consciousness-raising role (according to Vygotskij) and they generally contributed to developing competence in mathematical concepts.
- Passing from common to mathematical language, the learners used a language which was tightly bound up with their own cultural/social experience. This language not only puts natural language in relation to mathematical one but also the concepts which can arise from daily life.
- From a multi-cultural point of view, it is important to highlight that the use of cartoons proved to be an excellent communicative tool. Thanks to their iconic code, cartoons evoke lived experiences which diminished linguistic differences on entering and exiting the cartoon. The learners not only understood the problem, but they produced a purely personal iconic code for communicating logical procedures, the meanings of some calculations and even the organisation of some of the same data.

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