

## Discovering friction at preschool age: the dynamic of dialogues with five years old children about rolling objects

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### ABSTRACT

This paper presents certain qualitative results of a pilot study concerning the development and evaluation of a teaching strategy based on the construction of a precursor model in developing understanding of the concept of the rolling friction in children of 5 years of age. The aim of this study was to explore the extent to which nature and the characteristics of a teaching intervention can bring about cognitive progress in preschoolers with regard to the factors rolling friction depends on, when it is applied to an object that is freely rolling on a horizontal surface.

### Key words - Indexing terms

Friction, preschool age, children's representations, precursor model.

### INTRODUCTION AND THEORETICAL FRAMEWORK

The way the natural world is construed in the mind of young children has been and still is a topic of interest for several learning theories from the sciences of Psychology and the Epistemology of Learning. It is a typical trend in the field of Science Education, that when studying pupils' mental representations and the relative issues of conceptual change, very little attention is paid to preschool age children. Some recent studies performed on children aged 5-6, showed exactly the same results as relevant studies which used older children as their subjects. On the one hand, these studies showed that alternative representations in the thought of preschoolers are marked by characteristics that are fairly distanced from the characteristics of Science Education models, while on the other hand they demonstrated the possibility to transform them through properly designed teaching interventions (Zogza & Papamichael, 2000; Tsatsaroni, Ravanis & Falaga, 2003; Christidou & Hatzinikita, 2006; Kampeza & Ravanis, 2009).

An exceptional strategy along these lines is based on the assumption that learning is the product of systematic social, teaching and educational interaction, performed on targets which we have designated by research to constitute obstacles to children's thought (Martinand, 1986; Ravanis, 1996). This perspective renders it possible to work with young children in order not only to make some simple progress but also to build "precursor models" in their thought. Precursor models are cognitive entities of limited range as far as use and practice is concerned, which include a restricted number of elements and relationships from the actual scientific models (Lemeignan & Weil-Barais, 1993. Weil-Barais, 2001; Koliopoulos et al., 2004). Thus, if precursor models are efficaciously created, since these become established as intermediate entities between the children's first spontaneous mental representations and the scientific models, they may offer certain crucial possibilities: namely, the systematization and explicit expression of individual and implicit mental representations, the understanding of simple causal relations and the isolation of variables. It is exactly for this reason that precursor models fittingly prepare young children's thought for the creation of actual scientific models. The research presented herein is based on this notion and is related to the construction of a precursor model for rolling friction in preschool children's thought.

The rolling friction is a physical phenomenon, which impedes the rolling of an object on the surface of another. In the case of an object rolling on an horizontal level, the rolling friction depends on two factors: the weight of the moving object and the nature of the surfaces in contact. If a child understands that the rolling movement of an object on an horizontal surface depends on these two factors, then in fact he handles in a functional way the parameters which the rolling friction is related to.

The topic of representations of friction has already been studied in the field of Science Education in a series of studies from 5 to 16 year old students. It has been shown that explanations pertaining to pupils' thoughts about friction are not compatible with the scientific model. This underlines the need for organising suitable teaching for achieving conceptual change (Tsagliotis, 1997; Stead & Osborne, 1981; Kanari & Millar, 2000; Ravanis, Koliopoulos & Hadjigeorgiou, 2004).

In this study, is presented an effort of teaching interaction with pre-school children, having as an object the understanding of the factors which the rolling friction depends on when it is performed on an object that freely rolls on an horizontal level.

In the theoretical frame in which this particular study has taken place, the “learning” is recognised as a product of social interactions and exchanges during the teaching processes (Dedes & Ravanis, 2009a, 2009b; Fleer & March, 2009; Robbins, 2009; Zacharos & Chassapis, 2012).

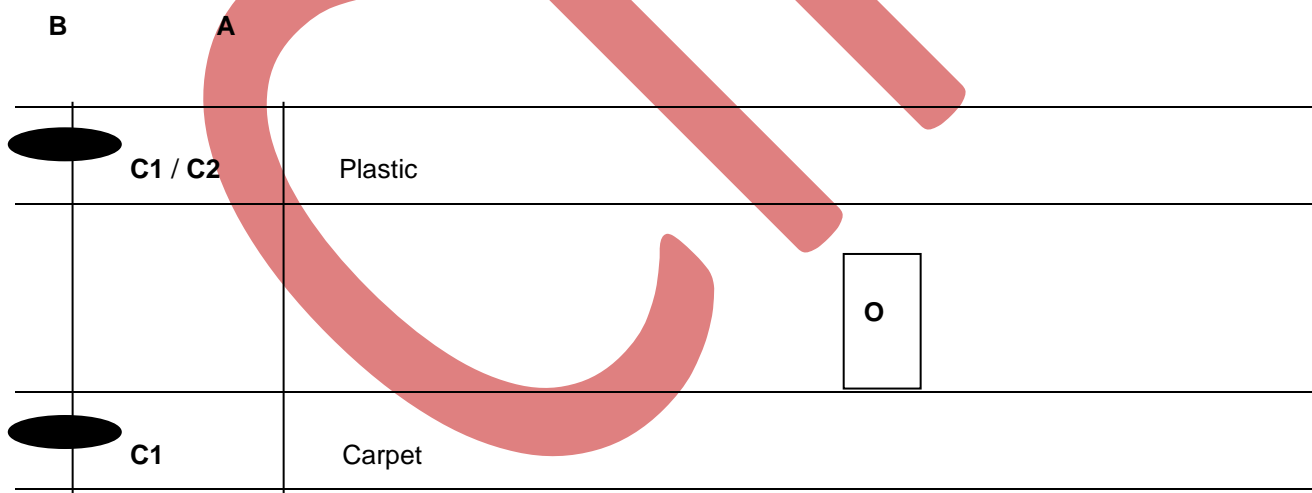
## METHODOLOGICAL FRAMEWORK

### Subjects

The sample of the study consisted of 19 pre-school children whose mean age was 5 years and 2 months with a standard deviation of 3.5 months. The subjects were randomly selected among the total number of children of two kindergartens from which some children, who were unwilling to participate, were excluded. None of the children had previously any formal instruction or involvement in discussions concerning the respective topics. The two kindergartens came from the same location in the city of Patras in Greece representing a population of mixed socio-economic status.

### The teaching materials

The following materials were used throughout the teaching intervention: (a) Two identical toy-cars (C1 and C2) which store energy when rolled backwards, so that they can then spring forward when released. We attach a small yet heavy box to one of the two toy-cars (C2). (b) Two elongated tracks, one made of smooth plastic and the other made of carpeting, both placed parallel to the floor. The rolling of the cars on the surface of these tracks takes place under different conditions of rolling friction. The toy-car deposits the same quantity of energy during all the phases of the process, since it goes backwards covering always a stable distance. One researcher asks the child to leave the car free on the plastic corridor and to note the point where it stopped. Then he asks the child to predict and confirm if the same car, carrying a lot of weight, would stop at the same point. In the end she asks the same prediction and experimental confirmation for the toy-car movement on the corridor made from carpet (see Figure).



Figure

### The process

With a pre-test we verified that the children of the sample did not recognise the one or/and the two factors, which the friction depends on. The research was carried out in special schoolrooms, where children were interviewed individually. A researcher on the basis of natural observation and the analysis of the tapes recorded the efforts of the subjects. Moreover, during the experiment, a protocol of non-verbal attitudes is filled in, in which the duration of the occupation with the task is recorded. The process is interrupted when the children carry out successfully the experimental procedure, or when, after failing, they stop working.

Two researchers and one child participate in the procedure at each session. One researcher poses the questions to the children. The other researcher states from the very beginning that he does not know the answers to the questions that are to be asked, but when he sees that a child needs some help he discusses with the child starting hypotheses.

During the process the dialogues between the child and the two researchers have as a point the children's guidance towards the understanding of the part of the weight of the moving object and of the surfaces' nature.

## RESULTS AND DISCUSSION

The analysis of the results has a qualitative character. In this particular point we chose and present two examples from the dialogs between the researchers and the children in which the meaning of the interactions during learning becomes clear.

### a) The recognition of the role of the weight

More of the half children during the pre-test had difficulty in understanding the part of the weight in the movement impediment. So this was the first obstacle of the experimental procedure (Martinand, 1986). Let's take a look at an example, in which the two researchers (Mary, Kostas) work with a boy of 5 years and one month old (Christos).

1. M. As you've shown me, if I drag the car from this line (A) to the other (B), it will be ready to start. His driver wants to go to his office (O) to work. Let's leave it free to see if it's going to reach there.
2. C. It's there.
3. M. It's there. Another morning the driver loads the car with a bag with several things and wants to reach at his office again. What do you think, he's going to make it?
4. C. ... He is.
5. M. Let's see (we leave the toy-car from the position B since we drag it backwards from the position A)... He did reach?
6. C. No.
7. M. Why, this time it didn't reach at the same point?
8. C. It hadn't had a lot of force?
9. M. What do you think Kostas?
10. K. I don't know....but it seems to me that we put the same force to the loaded object as much as to the other..... what did we do to make it leave, Chris?
11. C. We moved it from here (A) to here (B).
12. M. So, has it changed anything from before?
13. C. No.
14. K. No this car started the same way as before.
15. M. So, why it didn't make it to reach at the office as before?
16. C. ...
17. K. Something else must be happening...Something else must have changed....
18. M. What did we change on the car? What do you think Chris?
19. C. The suitcase?
20. K. Oh, yes. Now the car is loaded. Is it the suitcase to blame?
21. C. Let's put it out and do the same again to see where it is going to reach at...
22. M. Good. We put out the bag, we move the car from the one line (A) to the other (B) and we leave it.
23. C. It has reached.
24. K. So, what was wrong and it couldn't reach before?
25. C. It was the suitcase... If the trucks are loaded they move with difficulty on the acclivity outside my house.
26. M. So if we load the car again with the bag and we leave it is it going to reach at the office (O)?
27. C. No.
28. M. Why?
29. C. Because it is loaded, it is heavier.

### b) The recognition of the role of the surface nature

During the pre-test more of the three quarters of the children did not recognise that the differences in the surfaces' nature are responsible for the different space that an object rolls on the ground. This was the second target-obstacle of the experimental procedure. Let's take a look at an example in which the same experimenters work with a girl 4years and 11months old (Helen).

1. Let's take a look at something else now, Helen. One day the car begins to go to the office from this way (carpet). It leaves again from this line (A) and goes to the other (B) in order to start. What do you think is it going to reach at the office (O)?
2. H. Yes, of course...
3. M. Let's watch it (we leave the car and it stops before point O). Has it reached?
4. H. No.
5. M. Why hasn't it reached now?

6. H. ...I don't know.
7. M. What do you think about it?
8. H. ...
9. M. Kostas are you thinking of something?
10. K. I'm not sure.... I'm thinking may be it's the road.
11. H. Yes, it's the road.
12. M. What do you mean?
13. K. I don't know how to explain it...
14. H. The road is somehow now ... there are the hair from the carpet that it doesn't leave it to reach there.
15. K. Yes the road is a little bit different ...
16. M. Could you explain it to me a little better, so that I can understand what you're saying. Is this road by any means different?
17. H. Yes, because the other one was like ... Like glass, shiny and it let it move. The carpet makes it difficult.

From the presentation of these dialogues we have a slight sample of the dynamic of the communication between researchers and children on the topic of the understanding of the part of the weight and the nature of the surfaces as far as it concerns the objects' rolling. This observation is confirmed by the quantitative data (Ravanis, Koliopoulos & Boilevin, 2008), that arise from the comparison between the results of the pre and post-test as well as from the data of another relative to this subject research about the sliding friction.

From an analysis of the dialogues with the 19 subjects we verified that the presence of the second researcher who fakes not knowing the answers to the questions asked by the other researcher seems that doesn't help in particular. In a new research that is being realised, only one researcher participates.

The choice of the experimental design allows us to validate the cognitive capability of preschool age children to achieve construction of a precursor model, even if this takes place in a particularly favorable educational environment. Once we have established that the children are able to approach the cognitive parameters of this precursor model, we can then design teaching procedures within the same theoretical framework which will gradually approach actual kindergarten conditions.

Finally the role of the researchers had to do with the formation of these mental representations and with the effort to make them more explicit. In this perspective we can also build constructivist pertinent science curricula for preschool children and kindergartens (Koliopoulos & Ravanis, 2000).

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