

## **REPRESENTATIONS OF NEW COMPUTER TECHNOLOGIES MADE BY CHILDREN OF 9 TO 12 YEARS: COMPARATIVE STUDY BETWEEN GREEK AND FRENCH CHILDREN**

**Vassilis KOMIS**

Department of Computer Science, University of Crete, 71409, Heraklion, Greece  
komis@dia.csd.uh.gr

**Panayotis MICHAELIDES**

Department of Primary Education, University of Crete, 74100, Rethymno, Greece  
mixailid@ikaros.edu.uh.gr

### **ABSTRACT**

The representations made by children on new computer technologies and the interaction between these representations and real practice of children constitute a field which has been little exploited until today. The comparison between the representations made by French children who have been initiated in these technologies and by Greek children who had never been initiated in computers leads to interesting results. The structure and evolution of anthropomorphic and play representations and those influenced by science fiction are mainly connected to the children's age while the representations of computer use and those concerning the universal aspect of computers are correlated to real practice. The evolution of representations according to sex, age and computer possession is similar in both cases.

### **1. INTRODUCTION**

Studies in education and cognitive psychology have drawn a new consensus on the nature of the learner and his/her activities. According to J.-M. Albertini [1], the learner, through observations and experiences, acquires an “individual vision of the world”, a representation device from which he/she acquires knowledge progressively and learns his/her own knowledge. This makes the educational problems more complex to solve. Because the learner does not only have to have access to new knowledge, he/she has to integrate it into his/her spontaneous and naive system which might be judged as “erroneous” by experts. In that way, our representation of the world is nothing but an incomplete and partial vision of reality. At the same time, the learner does not simply acquire his/her knowledge but also determines his/her own learning process. Only when a knowledge takes on a particular sense for the learner, it is appropriated and can make his/her system of representations progress.

It is difficult to define the term of representation. According to M. Linard [2], it is characterised by the procedures and resulting products, apprehension, a more or less coded transcription, memorisation and every device considered as a system in interaction with its environment. This representation forms a concept-link between the different modes of our intellectual activity (physical, mental, individual, social, cognitive and affective) and occupies a crucial place in education and training. It becomes even more crucial as electronic machines proliferate artificial representations in our everyday-life exacerbating them under their double form: sensible global analogy (image) on the one hand, and abstract analytical logic (programmes), on the other [3]. Our research on children's representations of new computer technologies is based on this context.

The notion of representation appears more and more as a necessary tool for the teacher who is anxious to understand his students' reasoning as well as the way they “build” reality [4]. However, the notional reference scope which differs from one lesson to the other, plays an essential part in representation study. In consequence, every time a question rises on the didactic status of representations for teaching computer technology or a computer assisted lesson, it would be preferable to distinguish certain specific aspects of extreme importance.

As for the teaching of computers (which is not the subject of our study), it would be preferable to bring out the students' representations concerning the concepts of computer science. On the other hand, in elementary school as well as for the lessons where computer tools are used, it is more interesting to study the students' attitude towards the notions of computing and new technologies as well as the way they represent technological objects - devices designed for precise purposes and therefore, finalised objects - such as the computer, the came scope etc. Consequently, we should explore, above all, their representations in terms of a scientific and technological initiation. Such a study will prove to be of a considerable value because of today's fast technological changes. Therefore, it is urgent to understand how the children's representations on computer sciences operation and how they are connected to social practice. In this context, studying the representations of a technological object made by students while learning to use that tool, presents a double aspect: the representation induced by the tool itself as a system of reference with its own operation system, on the one hand, and the operator-user's representation, on the other [5]. This representation is not unique: each user builds up its own representation. Therefore, we should compare it to that of the expert who is supposed to master perfectly that tool.

## 2. METHODOLOGY

We examined the representations of children from 9 to 12 years and made a comparative study between children already initiated in new computer technology (the case of France) and children not initiated in computers (the case of Greece). This is a turning point in children's lives: they have to pass from primary school to college. The global teaching in primary school should lead children to a certain intellectual maturity in order to help them face teaching lesson-by-lesson given by specialised teachers. This is the last stage where new educational technologies, thanks to their technological impact, can make all students equal, without being directly related to the one or the other teaching subject [6].

### 2.1. Subjects and Instrumentation

In the case of France, the research has been conducted according to the methods used by ethnologists and anthropologists. This means that "*observers*" and "*observed people*" participated in events where they all were actors. However, these events have been experienced differently by each one and every body has been implicated in them with his/her own way. During the school year, we have worked with 16 classes of CM1 and CM2 (350 students) for 1h30 per class and per week. 166 students have answered a questionnaire at the end of the school year. After thirty hours of specialised animated sessions on computer tools in a classroom equipped with ten computers, five graphic tables, a printer and a video camera connected to a computer operating with digitalisation software, children had to answer a questionnaire made up of 18 questions and drawn after another preliminary questionnaire at the beginning of the school year and completed by observations during animated sessions, by informal conversations between children and teachers accompanying the students. We work with data collected in computer classes, sometimes in front of an instructor. Given that the representation (or the level of representation) made by children depends on the situation and what is in stake, we have to consider the emergence scope for our analysis. The computer animation contents have focused on five general lines :

- promoting the development of a computer culture;
- bringing basic technical knowledge on the operating principles of a computer system;
- finding and exploring different fields of computer applications;
- initiation in LOGO language;
- conceiving and realising multidisciplinary projects.

The same questionnaire has been translated and distributed in three colleges in Greece at the beginning of the school year. In this case, the public had never followed a computer course; its knowledge on new technologies, if any, came from outside school activities. The data was collected in three classes of the first college year (children from 11 to 13 years of age), from children who had just finished the elementary school.

### 2.2. Data analysis

As for the data analysis, we have proceeded in three stages: first, an elementary statistic analysis treated each question-variable separately. Therefore, it was possible for us to draw the basic lines of our study and to see the attitude of different groups which made up the study's population; second, a qualitative analysis was based on children's speech and gave us the possibility to identify the extent of representations on new technologies; third, we proceeded in a global statistic analysis using the method of factor analysis of various correlations [7]. We had to study the global structures of representations and to draw a topography which enabled us to see which representations were "attracted" to each other and which were "rejected". Such an analysis is interesting if we want to draw a cartography of the elements structuring the children's representations [8], [9]. Implicating nearly all the variables, we wanted to stress out the principles organising the differences between individual answers and tried to rebuild the common organising principles of different groups of children.

## 3. RESULTS

### 3.1. The case of France

We have proceeded in a global analysis using all the variables on the data table according to the answers given by French children except the answers whose mode represents more than 90% of the answers and those of minor importance. It is evident that in this case (16 variables with 54 associated modes and 3 illustrative variables with 6 associated modes), a complete analysis is impossible. The group of points representing these 62 modes should have been presented by a vector space of dimension 54. The first three factors (Table 1) should be interpreted, because they help us find proper values tightly associated to each other (less than 1%). We shall evaluate the sub-space as defined by the axes associated to these proper values and not the axes separately, because their position in this sub-space is not significant.

Table 1

The importance of the first seven factors of the modes according to representations made by French children on new technologies.

FACTOR	PROPER VALUE	% EXPL.	% CUMUL.	HISTOGRAM OF PROPER VALUES
1	.1734	9.25	9.25	*****
2	.1594	8.50	17.75	*****
3	.1151	6.14	23.89	*****
4	.1016	5.42	29.31	*****
5	.0913	4.87	34.18	*****
6	.0883	4.71	38.89	*****
7	.0810	4.32	43.21	*****

The first factor (diagram 1) is the 9.25% of the whole variance whose proper value has a square root of 0.42, which means that there is a quite strong correlation between the lines and the columns of the data table. This axis is formed by anthropomorphic [10] and play [11] representations; on the negative side of the axis, there are anthropomorphic representations not connected to emotions, representations strongly influenced by science fiction, play representations and answers concerning the computer as a tool capable of solving all problems, answering all questions (universal machine); on the positive side, we can see confuse representations connected to science fiction, representations rejecting the concept of universal machine and confuse representations concerning the anthropomorphic aspect of computers.

The second factor is the 8.50% of the whole variance and represents 0.40 of the correlation between the modes; this is the axis of the main opposition. On the negative side of the axis, we can see the most extreme anthropomorphic representations, emotions included, the representations influenced by science fiction, the image of the computer-“game” and the “computer-universal machine” (it knows everything, solves the problems, contains many information); on the positive side, there are representations rejecting the anthropomorphic aspect which are not influenced by science fiction and representations focusing on the functional use of new technologies and various ways of use. The third factor stresses out the differences and the common elements at the previous stage of the analysis. Therefore, we can distinguish one group made of play and anthropomorphic representations, “emotions” included; this group is slightly influenced by science fiction and the idea of the computer as a “universal machine” is not involved. On the other side of the axis, we can distinguish another group in contrast with the previous group: this group is characterised by the notion of functional work [12], of various ways of use, by the idea of “computer = universal machine”; the anthropomorphic representations are not included in this group.

The plan formed by the first two axes (diagram 1), helps us form three groups of distinct representations. The first group (cloud N1) situated at the bottom of the first axis is mainly made up of anthropomorphic representations, play representations and representations attributing a universal aspect to the computer (these are representations full of images and conceptual representations related to the confusion between reality and imagination). The second group (cloud N2) appears on the first axis on the right side of the plan and includes confuse representations on the computer's anthropomorphic aspect and on the influence of science fiction. The third group (cloud N3) is situated on the second axis, at the top of the plan; it contains representations based on the functional aspect of computers and ways of use; as well as representations rejecting the universal idea of computers and not connected to science fiction (conceptual representations and representations connected to action).

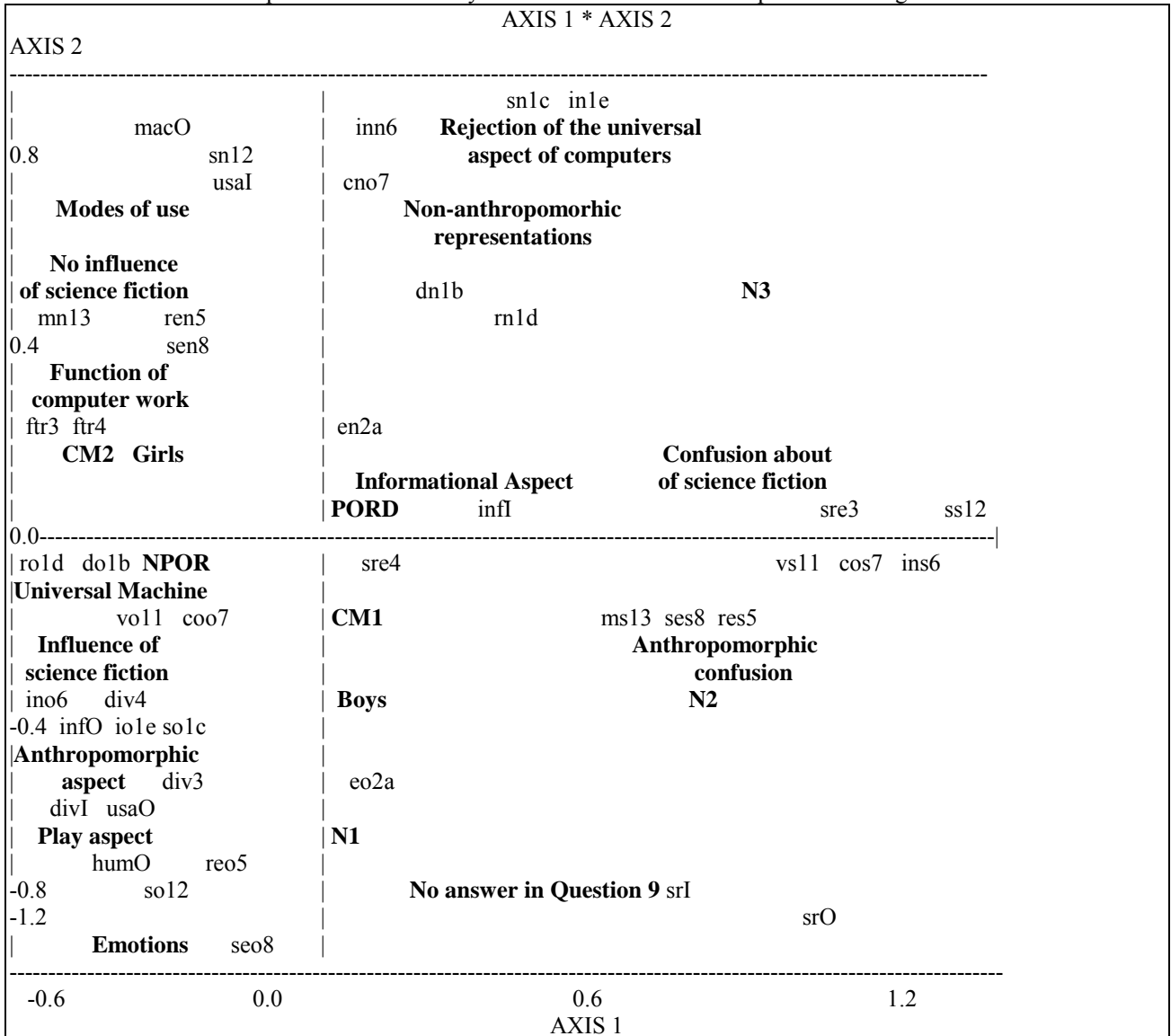
The cloud made by modes could be considered as a parabola, which leads again to the “Gouttman effect”. The Gouttman effect explains graphically the important connection between the modes implied in the analysis. The increasing form of the modality cloud does not only explains the opposition between representations of children but also an evolutive tendency. On the one hand, the graph's part which is limited by the negative sides of the axes, contains representations structured according to general false knowledge (e.g. the computer has the same abilities as people and is considered as a perfect tool); on the other hand, the other side of the graph which contains the opposite pole of representations, is made up of representations close to the actual knowledge (concepts). We can pass from the south to the north pole of the graph (diagram 1) through the first axis, on the right side, where one can find all the modes expressing children's confusion on new technologies.

We must point out that the attitude of different groups of children is similar to the remarks made at the previous stages of analysis. Therefore, girls, CM2 students and computer owners belong to the group of representations structured according to the idea of functional computer work while boys, CM1 students and students not owing a computer adopt the play and anthropomorphic aspect of computers. These tendencies do not have the same causes. If the representations made by children not owing a computer were play representations, they can be connected to each other being the satisfaction of a certain need. As for boys, they are much more attracted to mechanic tools than girls and to computers, in particular. Therefore, it is not strange why their attitude is visibly irrational. Another factor we should take into consideration is the level of intellectual maturity which is usually more precocious for girls. The intellectual maturity according to age can be connected to the gap between CM1 and CM2 students.

The graphic representation helps us proceed to more refined analysis on the specific modes whose position are considerably different from the other modes of the same group. This is the case of the mode seo8 (a computer can have

emotions) at the bottom of the graph. Modes srI, srO, concerning the case of “no answer” in question 9 (which words come to your mind each time you hear the words computer and Computer Science) are far from the main cloud, with an absurd position into the usual structure. This can be explained by the fact that some children have not answered to that question which required a great amount of thought and intellectual effort. We must also point out that modes concerning children owing a computer (mode PORD) and children not owing a computer (mode NPOR) are very close to each other but well separated by the axes. This result proves that there is a slight influence (as a variable). It is important to stress out the connection of status variables (such as sex, class etc) around the origin of the axes. This means that these variables are generally independent from each other and that their connection to opinion variables (such as children's representations) is insignificant.

DIAGRAM 1  
Representations made by French children on new computer technologies



### 3.2. The case of Greece

We have also proceeded in a global analysis which implicated all the data variables concerning the answers of Greek students except the answers whose mode represents more than 90% of the answers. We drew the elements structuring the representations of Greek children, updated the organising principles of the differences between the individual answers and tried to restore the organising principles which were common to all groups.

The table below indicates the importance of the first nine factors which build up 63.79% of the information in the table.

Table 2

The importance of the first seven factors of all modes according to representations made by Greek children on new technologies.

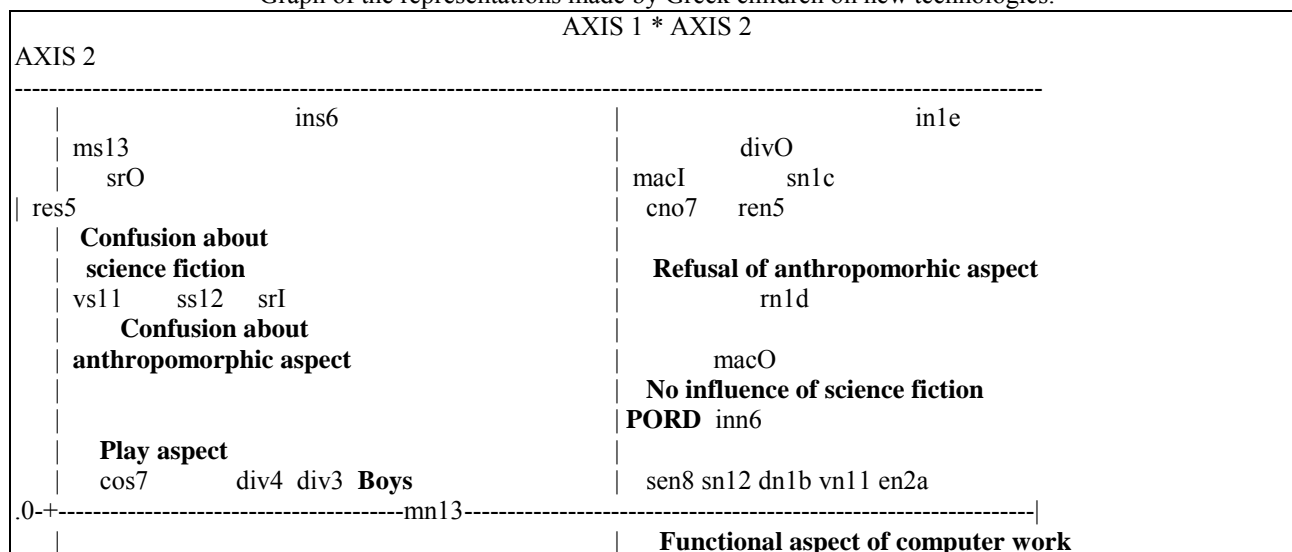
FACTOR	PROPER VALUE	% EXPL.	% CUMUL.	HISTOGRAM OF PROPER VALUES
1	.2253	13.35	13.35	*****
2	.1753	10.39	23.74	*****
3	.1343	7.96	31.69	*****
4	.1085	6.43	38.12	*****
5	.1054	6.25	44.37	*****
6	.0999	5.92	50.29	*****
7	.0806	4.78	55.07	*****

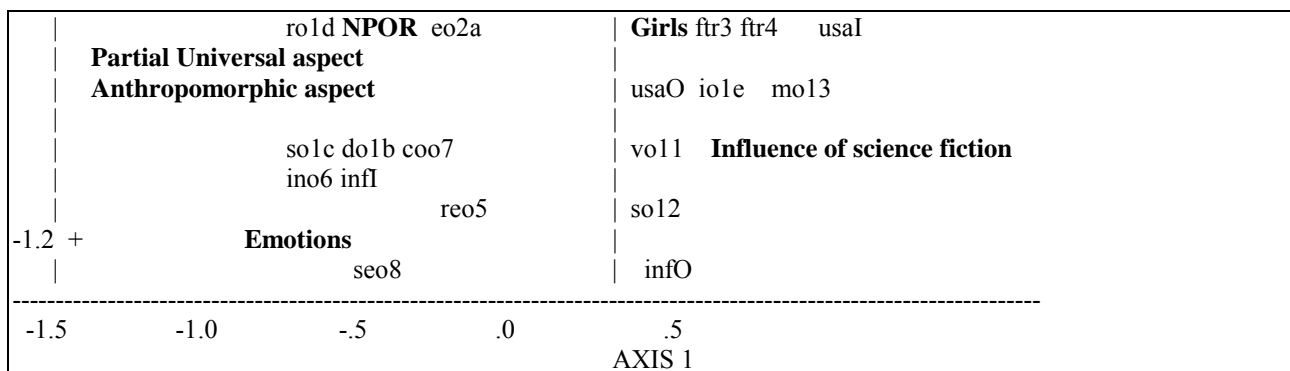
The first axis represents 13.35% of the variance and 0.48 of the correlation between the lines and the columns. At the negative side, we can find the modes resulting from confuse representations on science fiction, the confuse modes on the anthropomorphic aspect of computers and the fact that computers solve many problems and know many things. At the positive side, we can see the modes which reject the anthropomorphic aspect of computers, the modalities which reject the journey in time and the possibility to learn everything and, on the other hand, the fact that we can make intelligent machines, the mode concerning the mechanical aspect of computers and the modes against computers as the means to solve problems. In fact, we must notice the opposition between confuse representations, and moderate and structured representations which refuse the anthropomorphic aspect of computers and which are slightly influenced by science fiction.

The second axis represents 10.39% of the information. On the one hand, at the negative side, we can find strongly anthropomorphic representations influenced by science fiction and close to the universal aspect of computers. On the other hand, at the positive side, we can find the confuse representations as to the anthropomorphic aspect and science fiction which reject the universal aspect of computers.

The plan formed by the two axes helps us draw a parabolic cloud which shows the existence of “Gouttman effect” [9]. Therefore, we can distinguish the connection between the modes on the data table. The cloud starts from the left side at the top of the plan and includes the confuse modes on science fiction and anthropomorphic representations; it decreases towards the origin where we can find play representations, anthropomorphic representations and those concerning the universal aspect of computers; then, it increases towards the right side, at the top of the plan which includes representations on the functional computer work, the ways of use, representations rejecting the universal and anthropomorphic aspect of computers. Boys and students not owing computers are situated at the centre of play and anthropomorphic representations while girls and students owing a computer are placed next to functional representations and those rejecting the anthropomorphic aspect and the influence of science fiction.

DIAGRAM 2  
Graph of the representations made by Greek children on new technologies.





#### 4. DISCUSSION - CONCLUSION

From the comparison between representations made by Greek and French children, we can draw two main information: First, in both cases, children's representations show a similar evolution which starts from highly anthropomorphic representations influenced by science fiction and by the universal aspect of computers [13]; then, this evolution goes through a phase of confusion and ends to representations of various modes of use which reject the anthropomorphic aspect of computers [14]. As for the different groups of children according to sex, age and computer owners, they show almost the same attitude in both cases: boys and students not owing a computer make less advanced representations than girls and students owing a computer. On the other hand, there are significant differences between French and Greek children. They concern the interior aspects of big groups of representations (anthropomorphic, or influenced by science fiction, by the ways of use etc.) as well as the relative weight of each representation into the group [15].

The anthropomorphic and play representations of French children are of much more importance; the main opposition of the factor analysis in the first axis concerns the opposition between the anthropomorphic and play representations on the one hand, and, on the other, the confusion created by the anthropomorphic aspect and science fiction. The main opposition for Greek children lies between the confusion created by the anthropomorphic aspect and science fiction on the one hand, and on the other, the moderate representations concerning the refusal of anthropomorphic aspect. Therefore, French children make representations which evolve from anthropomorphic and play towards confuse representations influenced by science fiction and anthropomorphic aspect before they reject these aspects. Greek children, on the other hand, present a higher degree of progress: their representations have many common points to adults' representations in terms of anthropomorphic aspect and science fiction. Then, for Greek children, the anthropomorphic representations and those influenced by science fiction occur in less frequency than French children. Therefore, it is possible for us to assume that the evolution of anthropomorphic and play representations, and of those influenced by science fiction (the demythification of new technologies) are mainly more related to the age bracket of children and less to their sex and real practice.

French children use new technologies more intensively and in an institutional context (in school); they make much more varying representations as for the logic of computer use and their functional properties. In terms of the computer as a universal machine, French children are divided in two distinct groups; the first group accepts that aspect and the second rejects it. Greek children, on the other hand, do not make representations of very diversified use; the universal aspect of computers plays an important role in their representations. Therefore, the evolution of representations concerning the use of new technologies as well as the representations of computers as universal machines (the logic of use) [16] are more connected to the effective exercise of children and less to age and sex. In this case, we can notice that the introduction of such technologies in education is very important and plays a dominating part for the structure and evolution of children's' representations. However, in the case of France as for the case of Greece, there is a great gap between the logic used by children and the technological logic which determines the computer operation as well as the operation of its peripherals. So, as J.-F. Boudinot and J. Perriault stressed out [17], the social history of technology shows that social logic is not superior to technological logic. Today, there is no adequate and developed device, at least in large-scale, capable of helping us to overcome this gap. This is the reason why new technologies applied in education have known such a little success in large-scale until recently.

#### REFERENCES

- [1] ALBERTINI(J.-M.), "Le développement des multimédias suppose des recherches de base" in GRANDBASTIEN (M.), Les technologies nouvelles dans l'enseignement général et technique : situation au terme des années 80 et propositions d'orientations pour la décennie à venir, DOCUMENTATION FRANCAISE, 1990, pp.221-234.
- [2] LINARD (M.), Des machines et des hommes, apprendre avec les nouvelles technologies, EDITIONS UNIVERSITAIRES, 1990.

- [3] LINARD (M.), “Les nouvelles technologies, moyen de repenser la formation des enseignants” in L’intégration de l’informatique dans l’enseignement et la formation des enseignants, Actes du colloque, January, 28-30, 1992, EPI, INRP, pp. 26-44.
- [4] ALBERTINI (J.-M.), DUSSAULT (G.), “Représentation et initiation scientifique et technique” in BELISLE (C.) et SCIELE (B.) (eds), Les savoirs dans les pratiques quotidiennes. Les savoirs dans les pratiques quotidiennes. Recherche sur les représentations, CNRS, 1984, pp. 304-320.
- [5] LEVY (J.-F.), Traitement de texte et bureaucratie, observations et propositions pour la formation professionnelle, INRP, rencontres pédagogiques, no 32, 1993.
- [6] BOSSUET (G.), L’ordinateur à l’école - le système LOGO, P.U.F., 1982.
- [7] BENZECRI (J.-P. et F.) et collaborateurs, Pratique de l’analyse des données, Analyse des correspondances, exposé élémentaire, DUNOD, 1980.
- [8] DOISE (W.), CLEMENCE (A.) et LORENZI-CIOLDI (F.), représentations sociales et analyse de données, PRESSES UNIVERSITAIRES DE GRENOBLE, 1992.
- [9] VOLLE (M.), Analyse des données, Economica, 1985.
- [10] TURKLE (S.), the second self, computers and human spirit, SIMON AND SCHUSTER, New York, 1984.
- [11] CERNUSCHI-SALKOFF (S.), “Micro-ordinateur à l’école primaire : imaginaires d’élèves” in Sciences et Médias, Penser Imaginer Connaître, DIDIER ERUDITION, no 5, 1988, pp. 113-135.
- [12] KOMIS (V.), “Discours et représentations des enfants autour des mots informatique et ordinateur” in revue E.P.I. (Enseignement Public et Informatique) no 73, March 1994, pp. 75-86.
- [13] KOMIS (V.), “Les nouvelles technologies de l’information et de la communication dans le processus d’apprentissage et application par l’étude de leurs représentations chez les élèves de 9 à 12 ans”, Phd Thesis, University Paris 7, December 1993.
- [14] KOMIS (V.), “Représentations des élèves de l’école primaire en situation d’initiation aux technologies informatiques” in actes des XV journées internationales sur la communication, l’éducation et la culture scientifiques et techniques, chamonix, April, 4-8, 1994, pp. 273-278.
- [15] KOMIS (V.), MICHAELIDES (P.), “Logiques d’usage et enseignement des nouvelles technologies à l’école élémentaire” in revue E.P.I. (Enseignement Public et Informatique) (in press).
- [16] PERRIAULT (J.), La logique de l’usage, FLAMMARION, 1989.
- [17] BOUDINOT (J.F.) et PERRIAULT (J.), Pratiques et représentations de l’ordinateur et du téléphone chez les enfants de 6 à 12 ans, INRP, 1983.