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

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ABSTRACT

The representations made by children on new computer technologies and the interaction between these representations and children’s practice 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 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 acquires, through observations and experiences, 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 knowledge acquires 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], the term indicates the procedures and the resulting products, the apprehension, the more or less coded transcription, the memorisation properties of every organism and every device that is conceived as a system while interacting with its environment. Representations form concept-links between the different modes of our intellectual activity (physical, mental, individual, social, cognitive and affective) and affect teachers’ and learners’ performance in education and training. It becomes even more crucial as computers proliferate artificial representations in everyday-life 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 concept of representation appears more often as a necessary tool for the teacher who attempts to understand his students' reasoning and the way they “build” reality [4]. Furthermore, the conceptual framework of each school subject affects the representations under study. There is a difference between questions students ask during a computer technology classroom or during a Computer Assisted Learning Session, and this sort of difference will be negotiated below.

Concerning computer technology teaching (which however, is not the subject of our study), it would be preferable to work on the students' representations concerning concepts met on the field of computer science. On the contrary, in elementary school and especially in classrooms where computers are used as tools for learning purposes, it seems more interesting to study the students' representations towards this sort of meditation, towards the way computer tools (specialised or free of content software such as word processors-spreadsheets) and functions become cognitive tools facilitating their learning process.

Consequently, we should explore, students’ representations in terms their initiation in the area of science and technology. This study would be useful also because of the insights we could get into the means students’ use to adapt to the rapid technological changes. Therefore, to understand how the children's representations on operate and how they are connected to social practice is a valuable task. In this context, studying the representations of a technological artefact made by students during the use of computer for learning purposes, gives us a twin source of data: the representation induced by the artefact itself as a system of reference with its own built in properties, on the one hand, and the user's representation of it, on the other [5]. This representation is not unique: each user builds up his/her own representation. Therefore, to achieve a better understanding of this representation, 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 to secondary school. The way courses are taught in primary school -one teacher for almost any course- should enable children to develop a certain intellectual maturity in order to help themselves face teaching given by separate teachers to more specialized courses. This, as often asserted, is the last stage where new educational technologies, because of their technological impact, can make all students equal, without being related in a unique way 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 actor, and every actor has been involved 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 teaching sessions on computers, children had to answer a questionnaire made up of 18 questions. These questions had been formed and worded as a result of a refining process on a preliminary-pilot questionnaire, on observations during teaching sessions and on informal conversations between children and teachers accompanying the students. Data were collected in computer classes, sometimes in the presence of the classroom teacher. Given that the representation (or the level of representation) made by children depends on the situation, we have to consider the emerging goals for our analysis. Outlining the contents of the teaching sessions we can identify five general goals: a. promote the development of a computer culture; b. develop basic technical knowledge on the operating principles of a computer system; c. find and explore different fields of computer applications; d. initiate LOGO language; e. conceive and realise multidisciplinary projects. The same questionnaire has been distributed in three secondary schools in Greece at the beginning of the school year. In the case of Greece, this was the first time students were following a computer course; their knowledge on computers and new technologies, if any, came from outside school activities. Data were collected in three classrooms of the first grade of gymnasium (children >11 to <13 years old), from children who had just finished the elementary school.

2.2. Data analysis

Concerning data analysis, we have proceeded in three stages: first, a descriptive statistical analysis for each question-variable separately. Therefore, it was possible for us to draw the basic framework of analysis of our study and to see the attitude of different groups which comprise 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 statistical analysis using the method of factor analysis of various correlations [7]. We had to study the global structures of representations and to draw a map 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 map of the elements structuring the children's representations [8], [9]. Implicating nearly all the variables in this analysis, we wanted to 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 of the data table according to the answers given by French children excluding a. the answers whose mode represents more than 90% of the answers and b. variables of minor importance. 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 five factors of the modes according to representations made by French children

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	*********************************

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 confusing representations connected to science fiction, representations rejecting the concept of universal machine and confusing 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 game 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 map 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 map 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 map; 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 picturing the “Gouttman effect” that 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. 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 profoundly 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

```
                                        AXIS 1 * AXIS 2
AXIS 2
---------------------------------------------------------------------------------------------
-
|            macO                |   inn6     rejection of the universal aspect of computers
0.8     usaI   sn12              |  cno7       sn1c   in1e
|    modes of use                |
|                                |  non-anthropomorhic  representations
|no influence of science fiction |        dn1b                          N3
|   mn13         ren5            |               rn1d
0.4              sen8            |
| function of computer work      |
|  ftr3  ftr4                    | en2a
|     CM2   Girls                |                           confusion about of science fiction
|                                |   informational aspect
|                                | PORD         infI                         sre3        ss12
0.0------------------------------------------------------------------------------------------|
| ro1d   do1b  NPOR              |   sre4                                vs11   cos7   ins6
| “universal machine”            |
|           vo11   coo7          | CM1                  ms13  ses8  res5
|  influence of science fiction  |                 anthropomorphic confusion
|  ino6     div4                 |  Boys                             N2
-0.4  infO  io1e so1c            |
| anthropomorphic aspect         |
|  div3                          |  eo2a
|     divI   usaO humO           |
|   play aspect    reo5          |  N1
-0.8            so12             |        no answer in Question 9  srI
-1.2 emotions      seo8          |                                            srO
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-0.6 0.0 0.6 1.2

AXIS 1

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 five factors which build up 44.37% of the information in the table.

Table 2

The importance of the first five factors of all modes according to representations made by Greek children

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	**********************

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 map 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 map 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 map 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

```
                                   AXIS 1 * AXIS 2
AXIS 2
----------------------------------------------------------------------------------------------------------------------------------------
-
   |   ms13                ins6                 |     divO   in1e
   |    srO                                     |  macI           sn1c
   |  res5                                      |   cno7    ren5
   |  confusion about science fiction           | refusal of anthropomorhic aspect
   |  vs11     ss12    srI                      |                rn1d
   | confusion about anthropomorphic aspect     | macO
   |                                            |   no influence of science fiction
   |                                            | PORD  inn6
   |    play aspect                             |
   |    cos7        div4  div3  Boys            |   sen8 sn12 dn1b vn11 en2a
.0-+----------------------------------mn13---------------------------------------------------------------------------------------
-|
   |                                            |     functional aspect of computer work
   |                        ro1d NPOR  eo2a     |  Girls ftr3 ftr4     usaI
   |   partial universal aspect                 |
   |   anthropomorphic aspect                   |  usaO  io1e   mo13
   |                                            |
   |                        so1c do1b coo7      |  vo11    influence of science fiction
   |                        ino6 infI           |
-1.2  +                emotions reo5            | so12
   |                              seo8          |   infO
----------------------------------------------------------------------------------------------------------------------------------------
  -1.5          -1.0           -.5           .0             .5
                                         AXIS 1
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4. DISCUSSION - CONCLUSION

From the comparison between representations made by Greek and French children, we can draw two main conclusions. 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 detailed 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, the confusion created by the anthropomorphic aspect and science fiction on the other. 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 very diversified representations of 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 dominant role 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.

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