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EXPLORING CHILDREN'S ABILITY TO CATEGORIZE AND SYMBOLIZE

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ABSTRACT

Cartographers categorize the features to be mapped according to their dimensions (i.e. point, linear, area) and according to their qualitative and quantitative inherent characteristics. This classification is crucial for the selection of the symbols. But are cartographers aware of the way children conceptualize the geographical space? Do cartographers know the way children categorize things (items) and especially geographical features in their environment? If we want to introduce children to cartographic concepts, we must try to meet their way of seeing the world around them. Starting from this point, an empirical study was designed for children aged 6 to 15, aiming to appraise their ability in categorizing geographical features they use and see in maps, as well as their ability in working with symbols.

INTRODUCTION

"Without the ability to categorize, we could not function at all" as cited by Lakoff (1987, p. 6). This general statement corresponds to the work of many psychologists who tried to analyze in depth how humans categorize. From their point of view categorization is defined as the ability "to treat a set of things as somehow equivalent, to put them in the same pile, or call them by the same name, or respond to them in the same way" (Neisser 1987, p. 1). From the cartographic perspective MacEachren (1995, p. 151) argues that "Without categorization, maps would not be possible." In the field of cartography classification is defined as the ordering, scaling, and grouping of features by their attributes and attribute values (Robinson et al. 1995).

There is no doubt that the process of categorization has important influence on the way a map can be read and even more on the way spatial information can be acquired by a map user. The process of categorization in the context of cartography demands more consideration when the map user is a child. MacEachren (1995, p.152) accented that "To make maps that work, we must depict categories using methods that match the structures of human mental categorization." A systematic analysis to the way children categorize geographical features through their interaction with maps poses the following questions: How children categorize geographical features? How children's ways of categorizing develops? How children categorize when they are asked to symbolize geographical features on a map? Are children's criteria of categorization related to the cartographic ones?

In the cartographic domain, Robinson et al. (1995) cites two common ways that classification is performed on maps: (i) by allocating similar qualitative attributes, such as land use or vegetation, into categories (cropland, forest) or quantitative attribute values into numerically defined groups; (ii) by modifying the attribute value at a selected location to create a "typical" feature for portrayal on the map. A more systematic approach to the categorization of spatial features depicted on topographic maps has been provided by Keates (1972). He defines a list of aspects of topographic features which could be examined in order to decide what characteristics might be used to distinguish one category from another, like basic type, composition, dimensions, appearance, function etc. In making the map most effect as a means of communication the map symbolization must enable the map user to grasp the different categories and subcategories of features depicted. A main function of symbols is not only to depict the individual feature in its true location but also to relate it to other features of similar type or to place it in a specific category (Keates 1972). The dimensions of symbols (point, line, area) along with the combinations of visual variables, enable the creation of symbols to represent unlimited categories of features and to define relationships among different categories.

From the perspective of psychologists, people can group objects in a number of ways: based on perceptual features (e.g. color or shape), by theme that is by a causal or temporal relation (e.g. grouping a spider and a web rather than a spider and a beetle) or taxonomically by kind or function (Goswami 1998). As Tversky (1985) explains both perceptual and thematic organization has a basis on visual world: perceptual grouping on salient visual features, and thematic groupings on familiar visual scenes. Taxonomic grouping is based on shared function or shared superordinate category. Categories have traditionally been treated as having hierarchical structure (Goswami 1998): (i) at a global or "superordinate" level, such as category of furniture;

(ii) at an intermediate level or "basic" level, such as chairs vs. tables; (iii) at a very detailed or "subordinate" level of individual kinds, such as armchairs vs. deck chairs.

Conceptual development is intimately linked to the ability to categorize. In the past decade there has been a dramatic change in thinking of children's ability to categorize objects as a result of researches findings (Deak and Bauer 1995, Goswami 1998). These findings challenge the traditional theories of cognitive development, which posited a striking age-related change in the criteria used to categorize objects. In traditional theories it was widely agreed that preschoolers are "perceptually bound" (Inhelder and Piaget 1964) and group objects on the basis of perceptual similarity, whereas older children and adults categorize on the basis of more abstract symbolic or conceptually important attributes, even if those attributes are not obvious. As it comes out from a more recent research, sensitivity to both basic-level and superordinate-level categories exists by at least 19 months (Bauer and Mandler 1989). Reviewing researches' findings Deak and Bauer (1995) suggest that by an early age (3 years) children can group objects according to a variety of relations (e.g. appearance, taxonomic, and thematic) between objects. By the age of four, children can use categories to support inductive inferences even when the category membership conflicts with appearances (Gelman and Markman 1986). The prevailing view that preschoolers more readily relate objects thematically than taxonomically in contrast with older children and adults comes into questions as in recent studies preschool children more often selected taxonomic relations than thematic (Osborne and Calhoun 1998). Deak and Bauer (1995, 1996) concluded that task, context, knowledge, and the particular kinds and combinations of information available to children all jointly constrain the categorization decisions. Tversky (1985) confirms that school-age children prefer object groupings based on the conceptual features underlying superordinate categorization. But on what basis children categorize the spatial features presented symbolically on a map is an issue of further examination.

The aim of this study is to examine developmentally children's ability to categorize geographical features and to symbolize them on a map by applying point symbols of varying hues. It also examines how an antecedent task of grouping the geographical features referred to by name had an effect on children's responses on symbolization of these features on the map.

METHODOLOGICAL APPROACH

Students from both elementary and high school were selected to participate. More specifically, from elementary school the participants were: students from the first grade (A) with no mapping experience; students from the third grade (C) who had their first experience with maps through an introductory course of geography; students from fifth grade (E) who had developed map skills to a certain extent from geographic courses. From high school, students of the third grade (F) were selected who had already attended to all geographic courses of compulsory education at this level. Each participant was given a large-scale paper map of a town along with sets of point symbols, of the same shape (square) and of different hue. The names of different geographical features were labelled on the map. All the features, with two exceptions, were written more than one time. The features belonged to the basic level of categorization and they could be grouped into superordinate categories based on their function with the exception of features related to water which could be grouped by perceptual characteristics. Each participant was asked to represent the features using the given symbol sets. The number of symbol sets was smaller than the number of different features in order to have the participant prompted for grouping the features. Half of the participants prior to the symbolization process on the map (categorizing on the map task) were asked to categorize those features, which were written on a paper (categorizing on the paper task). These participants represent the "categorizing on paper and map" group whereas the other half of participants the "categorizing only on map" group.

METHOD

A total of 128 children participated in the study. They were drawn from the first (32 students; mean age 7), third (31 students; mean age 9 years), and fifth grade (35 students; mean age 11 years) of a public elementary school, and from the third grade (30 students; mean age 15 years) of a high school. Both schools were located at Athens suburb. Approximately one half of the participants (63 students) belong to the group of "categorizing on paper and map" and the rest (65 students) to the group of "categorizing only on the map".
A list of seventeen geographical features was written on a paper to be used for the categorizing on paper task. The features, with the order included on the list, were: elementary school, theater, bus stop, swimming pool, cinema, kindergarten, pharmacy, train station, fountain, hospital, high school, infirmary, play-field, zoo, playground, gym and lyceum. The features were selected from the books of the first grade of elementary school. For the categorizing on map task a colorful paper map of scale 1:2000 was designed portraying a built-up area with roads, building blocks, buildings and green areas. The names of the features mentioned

above were written on the map more than one time, with the exception of the zoo and hospital which were written only one time, and the features were summed to thirty-six. Next to each feature's name there was a small sign indicating to the child where to put the symbol in order not to cover the texts. Cardboard squares (7X7 mm) constituted the symbol sets, which had the following hues: red, orange, yellow, green, blue, pink, and brown.

Each subject took the test in the presence of the experimenter at a quite room in the school. For the categorizing on the paper task, the experimenter said: "You have a list of features. Read all these features and then put them in groups. You can make as many groups as you want". The subjects of the first grade of elementary school were asked to read the list loudly. For the categorizing on the map task the experimenter said: "We are going to play a game with a map". The experimenter showed and described the map and explained that the different features written on the map had to be symbolized. It was made clear that a feature could be faced in more than one location and that the number of symbol sets was smaller than the number of different features. Participants who had executed the categorizing on the paper task could use the results of their categorization on the map task. After the subject symbolized the features, the experimenter asked him/her several questions like: "Is there a special reason that you chose this color to show this feature?", "Why did you choose the same color to represent these different features?" The experimenter wrote down all the answers. Finally, the map composed by each participant was captured and stored with a digital camera (Figure 1).

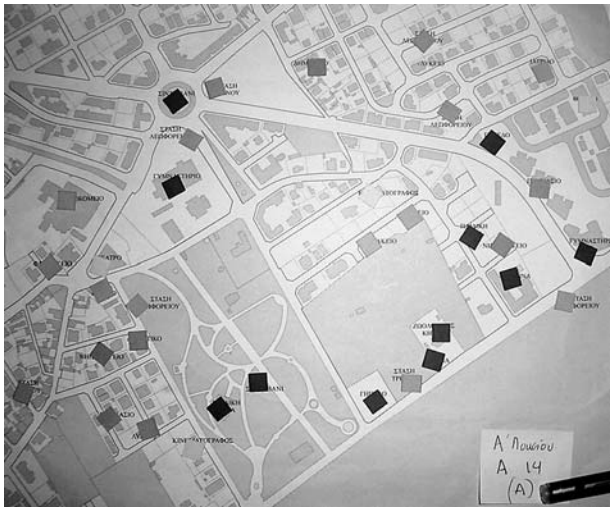

Figure 1. A map composed by a child

RESULTS AND DISCUSSION

In order to analyze the responses of the participants, the seventeen geographical features were categorized taxonomically into the following sets: EDU: kindergarten, elementary school, high school and lyceum; HEA: hospital, infirmary and pharmacy; TRA: bus stop and train station; ENT: cinema, theater, playground, play-field, zoo and gym; and the rest two were categorized on perceptual basis: WAT: swimming pool and fountain.

Subjects' responses on the categorizing on the paper task were examined whether they had followed the above grouping pattern and were divided into two classes (I & II). Six children (4 first graders, 1 fifth grader and 1 from third grade of high school) were excluded from any further examination since they did not apply any categorization. The class I is consisted of fifteen cases, which, with one or two deviations, the subjects followed the above categorization pattern or a more analytical one (e.g. set EDU could be divided into two subsets). The class II is consisted of forty-two cases, which the subjects followed the above categorization pattern or a more analytical one. First graders' responses were equally distributed to the two classes, whereas for the rest of the grades 25% of the responses fell into class I, and 75% of the responses fell into class II. Figure 2 illustrates the number of sets defined by subjects on the categorization on the paper task. The majority of subjects formed five to seven sets. Figure 3 represents the frequency (%) of subjects of the categorizing on the paper task that defined each of the five sets or their subsets mentioned above. From the first grade of elementary school children were able to categorize geographical features referred to by name. Third grade students of elementary school had very high performance reaching the level of students of fifth grade of elementary school and the third grade of high school. Children of all the grades categorized geographical features referred to by name taxonomically, as adults do, confirming the results of psychological studies mentioned in the introduction. It is remarkable that the set WAT, which was based on perceptual characteristics, was formed less than the others.

The second step was to examine whether subjects applied the process of categorization, when they symbolized the geographical features at the categorizing on the map task and to clarify on what basis they classified them, for example on perceptual characteristics, on function etc. The examination had two stages: if subjects used the same symbol (hue) to represent the same geographical features (consistency); if they used the same symbol (hue) to define a set of features. Table 1 represents for each grade, the number and percentage of subjects who consistently used the same symbol for the same features with no errors, with

one or two errors, with more than two errors. From the third grade the majority of children could symbolize the same feature with the same symbol on the map.

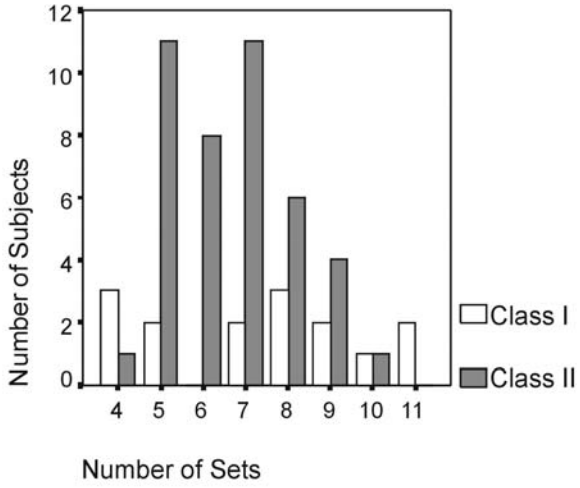

Figure 2. Frequencies of sets (categorizing on paper task)

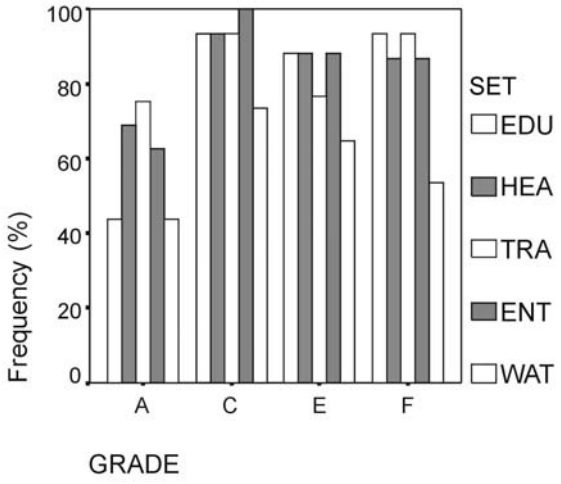

Figure 3. Frequencies of defined sets (categorizing on paper task)

Table 1. Map consistency of all subjects

Grade	A	C	E	F	Total
More than 2 errors	23 (72%)	11 (36%)	13 (37%)	5 (17%)	52 (41%)
1 or 2 errors	1 (3%)	5 (16%)	3 (9%)	5 (17%)	14 (11%)
Without errors	8 (25%)	15 (48%)	19 (54%)	20 (67%)	62 (48%)
Total	32 (100%)	31 (100%)	35 (100%)	30 (100%)	128 (100%)

Figure 4a shows, for each grade, the frequency of subjects (%) of the group "categorizing on paper and map" that displayed on their map 0 to 5 main sets, which were defined by different symbol (hue). Similarly, Figure 4b refers to the subjects of the group "categorizing only on map". Figure 5a shows analytically the frequency (%) of the subjects of the group "categorizing on paper and map" that formed each of the five categories described above. Similarly, Figure 5b refers to the subjects of the group "categorizing only on map". From Figures 4 & 5, it becomes apparent that the preceded categorizing on the paper task contributed to the more systematic application of the processes of categorization and especially for fifth graders (E) and the students of the third grade of high school (F). The set WAT was formed more than any other set at the process of categorization of geographical features on map in contrast with the categorization of the same features referred to by name. The results indicate the trend of the subjects to relate the hue of the symbols with the referent when there is perceptual support. The great majority of subjects (87%), who formed the set WAT, represented it with blue hue. The same attitude was revealed at the symbolization of other features and especially from younger children who justified for example the "red color" for hospital because of the red-cross and the "green color" for play-field because of the grass.

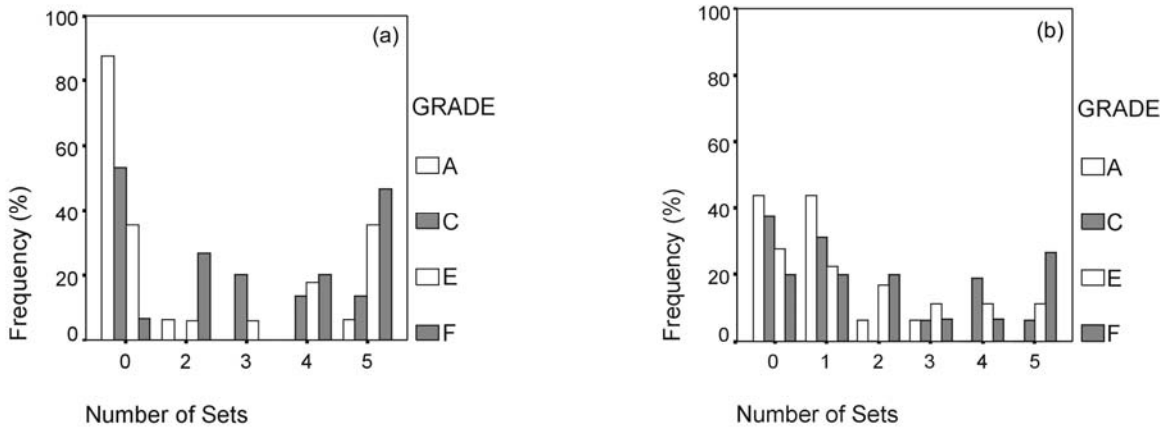

Figure 4. Frequencies of number of sets formed on maps (a) group "categorizing on the paper and map" and (b) group "categorizing only on the map"

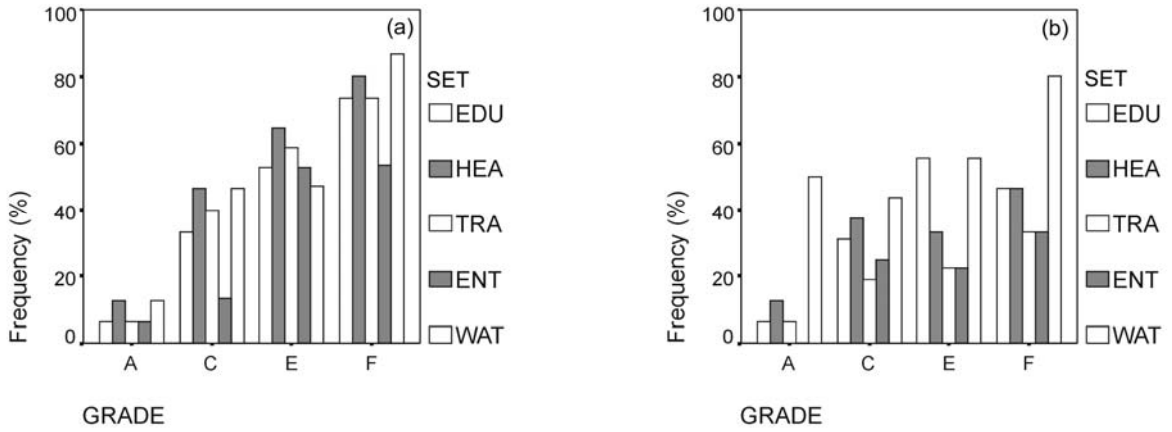

Figure 5. Frequencies of defined sets formed on maps (a) group "categorizing on the paper and map" and (b) group "categorizing only on the map"

The main result of the present study supports that the process of categorization geographical features referred to by names enhances children's ability especially aged 11 and 15 to categorize geographical features on maps. In this paper the first results of the analysis are cited and the collected data provides the opportunity for a more in depth analysis.

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