Icons versus symbols: investigating preschoolers' cartographic design

Sophia Goria & Maria Papadopoulou
< sophiagoria@gmail.com>, <papmari@gmail.com>

Making meaningful signs requires understanding both the informational and representational value of them. Signs convey specific information concerning the real object (referent) they "stand for" in an encrypted form. The current paper deals with the investigation of preschoolers' coding orientation of cartographic symbols. The main purpose of the study was to investigate the degree of iconicity applied by preschoolers in the cartographic design they produced. It is assumed that preschoolers mainly construct highly iconic cartographic symbols according to a naturalistic approach to coding orientation. An experimental research was conducted in 3 nursery schools in a rural area of central Greece and comparative, qualitative analysis of data gathered during the pre- and post-test process was implemented. The sample consisted of 24 children: 12 boys and 12 girls (aged 4 to 6). The results indicate that systematic exposure to conventional cartographic symbols along with planned instruction and explicit teaching of the principles of graphic design in a cooperative and authentic learning environment yields positive learning results regarding children's cartographic literacy.

Keywords: symbols, icons, cartographic signs & design, maps, visual communication, visual grammar, semiotic resources

1. Introduction

Cartographic signs convey meaning through graphic design. They employ a specific, culture dependent, semiotic system (Korpi & Ahonen-Rainio, 2010), and strictly conform to certain rules of visual communication and perception. Map users play a crucial role in the interpretative procedure. Multiple factors such as map users' cultural background, previous experience and awareness of visual semiotics – employed by graphic design – intervene in meaning making and strongly influence the interpretation of signs in many ways.

Signs used in maps are either arbitrary, abstract or iconic (Keates, 1996; Robinson et al., 1995; Rød, 2004). Various factors intervene in the viewers' understanding of signs, e.g. perception, previous knowledge, experience in map usage (Aanstoos, 2003), understanding the map's structural elements and the map maker's intentions (DeLoache, 2002; Myers & Liben, 2008; Sharon, 2005), level of iconicity or abstractness, individual differences (sex, age, interests) etc. Arbitrary map signs are grounded on convention and, therefore, are culturally orientated, while iconic map signs are naturalistically orientated in coding (Unsworth, 2001), which means that they depict the real world in great detail. Both unknown conventions and physical similarity to the "referent" require different interpretative processes, helping or hindering interpretative performance (DeLoache & Sharon, 2005). Abstract symbols may also cause problems in information transfer to map users, breed misinterpretations concerning what the visual scene evokes to the viewer (Nöth, 2003; Rambaldi, 2005) and therefore require a map legend to be comprehensible. In consequence, communication becomes ineffective. Hence, from an educational perspective the acquisition of cartographic language by novice and inexperienced map users is considered to be a key issue in contemporary educational issues. "Novices in any symbolic medium may need explicit tuition in order to master it" (Peralta de Mendoza & Salsa, 2003).

Children should be trained in an early age in how various graphic modes communicate information and, in particular, in the way symbols code information and produce meaning according to visual semiotic systems. It is obvious that being educated in the available semiotic resources – irrespectively of the representational mean that each mode employs to convey meaning (audio, visual, verbal, gesture, sound) – is an imperative social skill for individuals (Cope & Kalantzis, 2000) and their instruction should not be restricted to one specific subject area of the curriculum. Visual communication and cartographic design should be taught across the curriculum (Unsworth, 2001) and intertwined with various scientific content areas such as language, sciences, art, etc., which concurs with the interdisciplinary teaching approach.

2. Cartographic Communication

2.1 Maps

Maps convey spatial information about the environment (Anderson & Leinhardt, 2002) in an encrypted form: by means of symbols. Symbols represent reality: "All maps use signs (made up of marks such as dots, lines and colors) to stand for elements of reality, which comprise the map's symbology" (Wiegand, 2006). According to Bertin's (2011) cartographic semiology, map symbols are divided into point, line and area ones, while certain visual variables (shape, size, orientation, hue, grey tone value (light or dark) and texture) indicate geographic differences (such as bigger and darker shading circles represent populous areas). Specific visual variables are suitable to express qualitative or quantitative differences, while others are combined in numerous ways to convey certain meaning. The use of visual variables has to be considered "as a prerequisite knowledge for map use" (Filippakopoulou & Nakos, 2009) and understanding.

2.2. Cartographic Signs

Semiotics deals with the ways meaning is assigned to a sign. Cartographic signs have been systematically organised into categories, according to the aforementioned principles of Bertin's cartographic semiology, which led to the development of a typology that cartographers usually demonstrate in their design. Depending on the particular theoretical background, cartography provides various categorisations of cartographic signs and gives correspondent evidence on different factors that influence understanding and meaning comprehension. However, there is strong evidence that the effectiveness of cartographic signs on meaning comprehension relies on both children's understanding of "dual representation"[1] of signs (DeLoache, 2002) and the use of visual variables.

According to Peirce's semiotic model, signs are categorised into icons, indexes and symbols depending on their relation with the real world referent to which signs serve as a vehicle (Atkin, 2010). Icons relate to an object by similarity. Indexes provide clues indicating the existence of a real object and symbols are arbitrary or conventionally related to an

---

[1] Signs "stand for" another entity (object, idea, event) as they constitute the abstract form of our experience of the world in an effort to make sense of it, comprehend and construct it. According to this, signs "substitute" (Casti, 2006) experience and are generated from the transformation of experience into a sign (Feinstein, 1982). There is a fundamental difference between signs and symbols that has been recorded in pertinent literature. Feinstein (1982) supports that "signs are not invented by humans but merely observed and recorded by them", denote and are the same for all people while symbols "are invented by humans when a group of people agree that one thing shall stand for another", connote and are culturally dependent.

object due to laws, rules or reciprocal agreement. "Symbolizing is thus an act that assumes a background of shared rules and practices as an interpretive framework, and so budding child symbolizers must acquire something of these conventions before producing symbolic acts for others successfully" (Rakoczy et al., 2005). Additionally, an alternative categorisation of cartographic signs, depending on differences in the degree of iconicity[2] classifies signs into pictographic, associative and abstract ones (Robinson et al., 1995). However, a general agreement upon sign classification and a valid definition of specific categories into which each symbol would fall (MacEachren, 2004) is difficult to be accomplished. It has been admitted that signs inevitably can have characteristics from more than one category (Medynska-Gulij, 2008) and categorisation is performed "to assess different characteristics of signs" (Korpi & Ahonen-Rainio, 2010) in order to facilitate their study and promote better communication results. Cartographic communication is considered to be a successive process when spatial information has been successfully exchanged (sent to the map user); (Sluter, 2001) in order to produce understanding (Neytchev, 2008; Racine, 2002).

2.3 Preschoolers' Understanding of Symbols

In modern society, children are vastly exposed to symbolic artifacts. "To become functional members of any society, children must gain competence with symbols and symbol systems through which knowledge is acquired" (Deloache, 2004). Research on young children's understanding of symbols indicates that children are often confused about the nature of symbol-referent relations. Understanding of symbols requires understanding of the object-referent relation and the informational value of the sign along with the substitutional function of the sign (stands for a referent); (Downs et al.,1988; Thomas et al., 1994). If one can neither detect the information a sign conveys nor use it as a representation of its referent (dual representation), misunderstanding is the consequence (Leekam et al., 2008). Hence, this kind of misinterpretation may hinder competent communication.

The ability to derive proper meaning from symbols is developmentally related and gradually improved (Catling, 2005). This development is attributed to many factors but "cumulative experience with a variety of symbols presumably plays a prominent role" (Deloache, 2004). After the dual representation characteristic of symbols has been established, young children gain experience and knowledge concerning symbolic function and advance symbolic development through continuous and repetitive interaction with symbols available in their environment.

Research outcomes on young children's symbolic development and skills have important implications in designing appropriate educational materials. In addition, analysis of children's verbal or/and visual responses to cartographic symbols (talk about or/and design cartographic symbols) gives room for further exploration of how visual semiosis works. This leads to more accurate and concrete interpretations on behalf of young children, which allow them to communicate more properly. Lysaker (2006) points out that "becoming aware of the way that cartographic symbols produce meaning requires explicit teaching of visual grammar and planned instruction". Children should be aware of the principles of cartographic design and its structural elements in order to perceive world's meaning and enhance cognitive development.

---

[2] The term "iconicity" is used in the traditional sense [[as the relationship of similarity between the form of a sign and the object or concept it refers to in the world (http://es-dev.uzh.ch/en/iconicity/)] and therefore in contrast to its expanded and refined definition that is been proposed by current researchers (Koch, 2011).

3. The current study

The main purpose of the study was to investigate the degree of iconicity applied by pre-schoolers in their cartographic design. Particularly, the study examined the ways mainly used by preschoolers to convey spatial information by means of visual principles and graphical forms of depiction. What kind of cartographic typology do preschoolers' designs of map symbols demonstrate? Do they prefer to design iconic or symbolic signs? Which degree of iconicity (high to low) facilitates preschoolers' map reading and making?

3. 1 Method

The current paper deals with the investigation of preschoolers' coding orientation of cartographic symbols. It is part of a broader research project on map literacy conducted during the elaboration of a master thesis (Goria, 2007) which aimed "at investigating preschoolers' concepts on maps and the degree of their cartographic knowledge (decoding and designing skills) after the implementation of a project on map literacy" (Goria & Papadopoulou, 2008). We assumed that preschoolers mainly construct highly iconic cartographic symbols according to a naturalistic approach in coding orientation (pre-test). After being explicitly taught the structural characteristics of symbolic design and the principles of visual code and communication and being exposed to thoughtfully chosen exemplars of cartographic symbols, preschoolers acquire new knowledge that can be incorporated into their personal cartographic design (post-test).

Conducting the present research, the level of children's cartographic creativity and accuracy of depicting spatial information graphically using cartographic symbols has not been estimated. It is assumed that the investigation of cartographic signs generated by preschoolers during the pre- and post-test might offer insight into children's thinking concerning the way they handle information (produce and derive meaning) through the use of symbols.

In addition, information obtained by the assessment of children's sign production might contribute to both cartographic design (Wiegand, 2006; Medynska-Gulij, 2008) and educational decisions for developmentally appropriate map choices as learning tools. In educational settings, the use of cartographic signs should be thoroughly questioned whether its initiative goal, i.e.: effective communication, has been accomplished (Namy & Waxman, 2005). Otherwise, the use of maps becomes a disappointing task for children and in the long term, children will detest maps and avoid future engagement with them.

3.2 Participants

The research was implemented in three nursery schools in a rural area of central Greece. A total of twenty four children participated in the study: twelve boys (aged 4 to 6) and twelve girls (aged 4 to 6). The children's parents were laborers, farmers and employees educated up to secondary level.

3.3 Procedure

The present research followed various steps: selection of the sample; primary designs of cartographic symbols on a given sheet; teaching intervention; repetition of the design process of cartographic signs; analysis of selected data and comparative analysis of data gathered from both pre- and post-test. Experimental research was the method of choice.

The design task took place in a private room, inside the school building, under the discrete presence of the researcher. Each subject performed the assigned task individually in a given time (approximately 10-15 min.). Children were asked to design six symbols (houses, trees, school, playground, road and market) that could be applied on a map, on sheet pre-divided in two columns and six rows (cf. appendix A).

After gathering the data that children generated during the pre-test, a teaching intervention was designed and implemented.

3.4 Teaching intervention

Teaching intervention was designed carefully in order to focus on developmentally appropriate activities and playful tasks[3]. Children's interests and previous knowledge had to be taken into consideration. During the teaching intervention probands were exposed to frequently used map symbols. Subjects initially were stimulated to interpret symbols' assigned meaning spontaneously and justify their arguments. The same symbols served as a teaching model for the structural attributes (line, color, form, etc.) of cartographic signs during the teaching intervention. Analysis of children's discourse supplied the current investigation with information concerning preschoolers' reading strategies of symbolic forms. Such knowledge is supposed to be essential and at the same time a prerequisite for successful transmission to the following task of producing cartographic symbols by children in different communication contexts in order to convey meaning. In addition, children's misinterpretations were considered to be useful in revealing their misconceptions concerning cartographic knowledge. It was assumed that detailed examination of these misinterpretations might lead to more comprehensive and meaningful teaching of cartographic design. Cartographic symbols resemble code systems like language, and require learning in order to be adopted by its users. Learning occurs during the process of communicational situations in meaningful and authentic teaching environments.

The research was completed with a post-test. The post-test was identical to the pre-test and data was examined accordingly. The comparative analysis that was implemented in the data aimed to evaluate the degree of iconicity in map symbols produced by probands during the pre-test and after teaching intervention (post-test) related to cartographic typology. Children's responses to teaching intervention were equally taken into consideration.

3.5 Tools for the elaboration of the data

Qualitative analysis was conducted on the designs that the subjects generated during both pre and post-tests in order to evaluate the degree of iconicity in map symbols produced in both tasks. The answers were classified in two conceptual categories (Babbie, 2011; Hardy & Bryman, 2004), icons and symbols, according to the aforementioned functional definitions (cf. chapter 2). The results were described quantitatively and represented graphically by means of charts and tables.

---

[3]   Memo cards and sudoku with cartographic signs on them, memo games on the web etc.

4. Results

Qualitative analysis of data gathered during the pre-test indicated that preschoolers' cartographic designs concerning six signs (houses, trees, school, playground, road, market) included in a given sheet (cf. appendix A) were defined by a high degree of iconicity. Preschoolers generated icons (100%) exclusively versus symbols (0%) that resembled real objects by retaining shape and colour attributes of the referent (fig. 15). Houses were made up of both a square frame and a red triangle on top, which imitated the main building and the triangular shape of roofs respectively. Subsequently, the use of red colour for the roof tiles enhanced similarity with real houses and derived mental associations concerning buildings in general. Accordingly, trees were represented in brown and green colour, indicating two main features of tree designs: trunk and foliage.

In a few cartographic signs of trees a third part has been observed: roots or branches, equally in brown colour. These two features were expanded either beneath the tree's trunk or upwards and they were also visible as if the ground or the leaves were transparent (fig. 1 & 2).

Figure 1 & 2: Invisible parts of a tree are depicted in children's cartographic signs.

The brown outline of a rectangle or a rectangle filled with brown colour served as the tree's trunk, while a green, curved, closed and continuous outline upon the trunk stands for the tree's foliage (fig. 3). In some designs, the latter was filled with green colour providing with the impression of dense foliage (fig. 4).

Figure 3 & 4: Different designs of trunks and folliage.

However, the visual variable of size was used by preschoolers in order to denote differences in type and usage of buildings (fig. 5). As previously mentioned, houses were mainly depicted by a square with a triangular roof on top, sometimes supplemented with flowers, sky, sun etc.[4]. Preschoolers maintained the primary building form (a square and a triangle; cf. fig.6) and added more than two windows in a row and/or in a second row so

---

[4]   Detailed sketches with additional features of no informational value were mostly observed in girls' cartographic signs.

that the viewer gets the impression of two buildings different both in size and usage (fig. 7). For example, a school building is frequented by many students and, therefore, has to be bigger in size than a single-family house.

Figure 5-7: Children seem to use a basic design to depict buildings and modify this basic design regarding size (figure 5) and number of windows (figure 6-7) in order to differentiate between different types of buildings (e.g.: house, school, market).

Cartographic signs of houses were entirely represented by colourful designs of the previously described building form. However, in a few cases buildings of a school or a market were substituted by a more salient feature of the real object, i.e. a part is used for the whole (metonymy).

A table and a chair (fig. 8), a child playing (fig. 9.3) or a market trolley (fig. 17.3) served as cartographic signs of school or market respectively. Such metonymic practices increased in number and became more apparent and used by preschoolers in the post-test design task, after the completion of the teaching intervention.
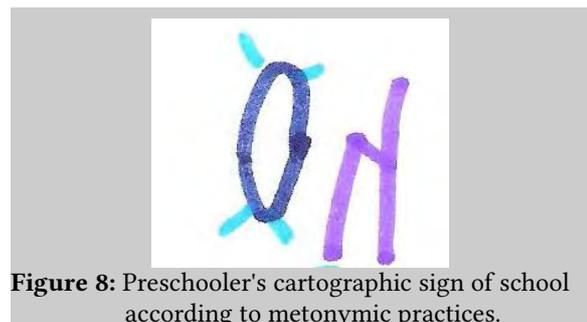

Figure 8: Preschooler's cartographic sign of school according to metonymic practices.

Based on the same design pattern that was used to depict houses or schools, the drawings of a market building differed from these types of buildings only by the addition of shelves for products or by the written label "market".

The cartographic design of a playground was represented by means of the most salient playground equipment: swings, roundabout, bar, seesaw, slide (fig. 9.4 - 9.6), which reduced in number after the teaching intervention. Preschoolers performed worse in the design task concerning the playground-sign: in some cases, they apparently gave up this particular task leaving blank space on the given sheet. Presumably, the playground theme was absent from their design repertoire or not well practiced yet, so that children refrained from depicting it.
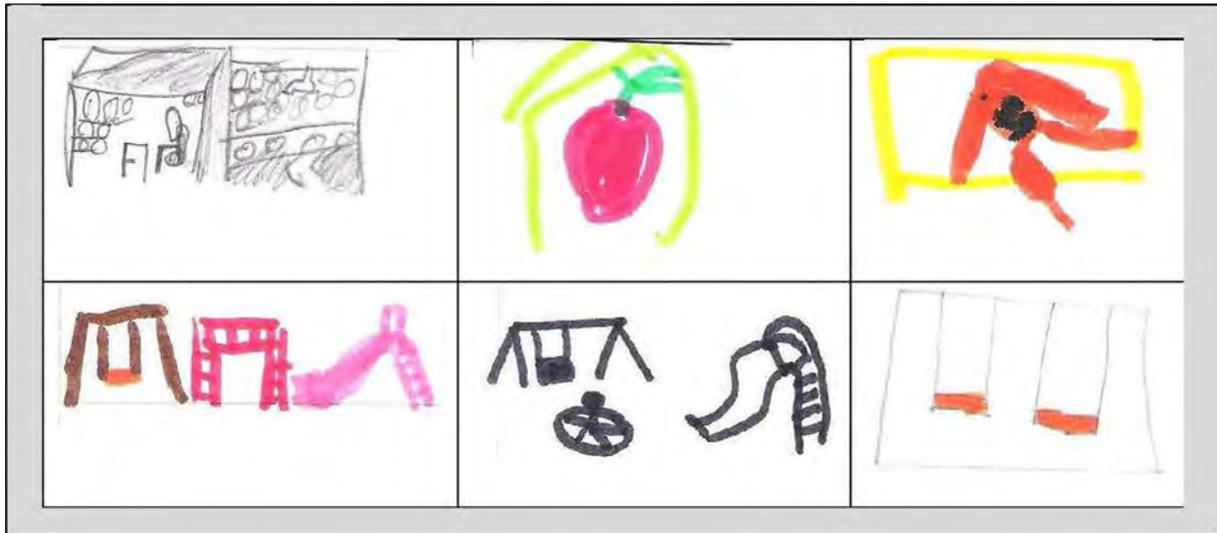
Figure 9: Signs of market (1,2), school (3) & a playground (4-6) that differ by objects of usage {(foods on shelves (1)}, foods to sell {(apple(2)} or subjects that use them {(students of a school (3)} or salient features of a playground.

Roads were depicted in the form of one – mostly grey and discontinuous – line or various lines (straight or curved), which were combined in different ways (parallel, crossed etc.) and formed also crossroads and junctions (fig. 10).
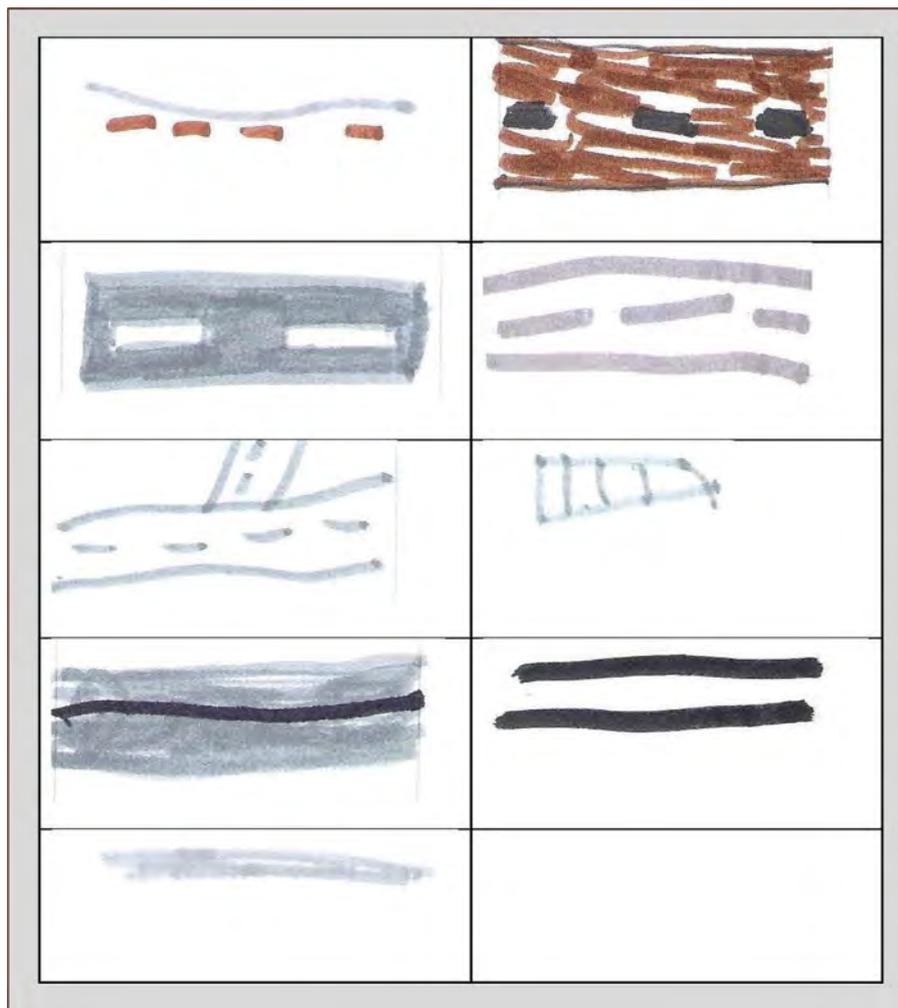

Figure 10: Various signs of "road" (grey lines in different combinations).

Analysis of the data gathered during the post-test revealed an increasing amount of symbolic signs (17%), although, and despite of the preceding teaching intervention (cf. appendix B), iconic signs are still observed (38%) in children's cartographic designs. Nonetheless, both symbolic and iconic signs coexist in a considerable amount in children's designs (42%).

More precisely, cartographic signs produced by preschoolers during the post-test tend to become simpler, plainer and also less iconic than those produced during the pre-test. Designs were arbitrary related to their referents due to certain conventions. A single grey line depicts graphically a real road (fig. 14), or a roundabout, which is part of playground equipment was chosen to represent the whole object. Children gradually began to design abstract cartographic symbols, which were no longer related to real objects by virtue of similarity, but rather in accordance with conventions that had been accepted, learned and recognized.

Repetition of the same design pattern during the pre- and post-test denoted plurality (two or more trees and houses; cf. fig. 11), while the whole object is represented metonymically by one of its parts: A roundabout stands for the playground or an apple for the market that sells it (fig. 9.2).

Cartographic signs of different building types maintained primary features (square with triangular roof) during the post-test. However they were deprived of additional attributes that enhanced iconicity (flowers, sun etc.) but have less salience.

Figure 11: Expressing "plurality" in visual mode.

Outline sketches, single lines, color associations with low detailed design were some of the characteristics of cartographic design of the second phase (post-test). Trees were related to real ones due to similarity to the outline sketch of a trunk and its foliage (fig. 12), while a single grey line depicted road effectively and adequately (fig. 13).

Figure 12 & 13: Examples of how preschoolers produced more abstract designs during the post-test.

5. Discussion

The results of the current research show that preschoolers produce iconic (Kynigos et al., 2001; Catling & Willy, 2009) rather than symbolic signs (fig. 14) – according to Pierce's definition and to the aforementioned distinction concerning definitions of sign and symbol. It has been upheld that preschoolers initially generate icons that substitute their experience gained through interaction with the real world. Through a continuous meaning making process, preschoolers strive for understanding the world and visually express knowledge that they have already gained.

Figure 14: Iconic and symbolic sign of a road.

The results indicate that systematic exposure to conventional cartographic symbols along with systematic instruction and explicit tuition[5] (Peralta de Mendoza & Salsa, 2003) of the principles of graphic design in a cooperative and authentic learning environment yields positive learning results concerning children's cartographic literacy (cf. appendix B). Preschoolers improve their understanding of how a semiotic system produces meaning and subsequently become capable of producing meaning on their own by applying accumulative knowledge on individual graphic designs (fig. 15). Children produce meaning in graphic modes according to existing conceptual schemata that have been formed due to previous exposure and manipulation of real objects. For example, the sample of the present research expressed graphically specific cognitive schemata relevant to the general concept of buildings and their variations that have been exploited and constructed during former exposure to real environmental stimulations.

More precisely, during the pre-test preschoolers produced iconic signs which "involved representation of static, perceptual features" rather than the action or the referent (Tolar et al., 2008). For example, the iconic sign of a road was depicted by a grey line and not by a person or a car in motion.

In addition, the most common design to represent a road was a discontinuous line (fig.10), which is in congruence with symbols' characteristic attributes of simplicity and abstractness. A symbol simply denotes meaning through the graphic design of a salient feature of the real object that "stands for" the whole. A white discontinuous line, for instance, is a salient feature of the real road, which it represents adequately in a graphic mode.

---

[5] "Here, we conceive instruction as the informational support that enables a child to detect and use a symbol–referent relation" (Peralta de Mendoza & Salsa, 2003)

Pre-test		Post-test
	houses	
	trees	
	school	
	playground	
	road	
	market	

Figure 15: Iconic signs produced during the pre-test (on the left) & symbol signs after the teaching intervention (on the right).

Detailed sketch, colours, shape and increased size concerning similar objects depicted are among the design practices that children demonstrated during the cartographic design task. Children applied previously mentioned practices in their designs to discriminate signs that refer to objects, which are included in identical conceptual categories, differing, however, in usage. Schools, houses and markets are included in the same conceptual category: buildings. Preschoolers replicated a well-known design schema of building that is frequently found in their drawings to represent all three kinds of buildings that the research task demanded (fig. 5-7 & 16).

However, a common feature in order to show diversity of building types could be observed in our data: gradually increased size. A school is bigger than a house and a market is bigger than both house and school (fig.6). Additionally, children enhanced their designs of different building types with salient features (trees for houses, baskets with fruits or trolleys for the market, children or/and playground for school) to denote different usage (fig. 9, 16, 17).
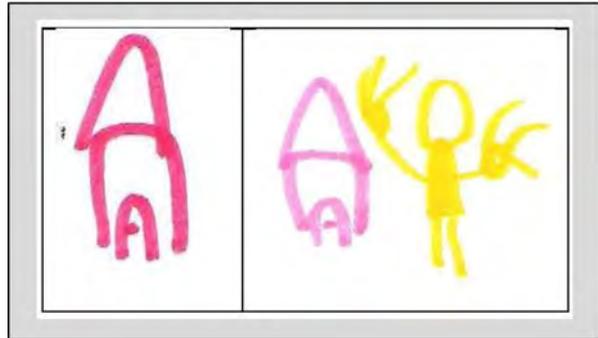

Figure 16: Signs of a house and a school. Children replicate a well known schema of "building".

Such practices can serve semiotic economy and enhance communication through imaginative use of the affordances of visual mode and therefore should not be perceived as a preschoolers' design deficit or inability to demonstrate alternative and refined design practices supported by different developmental stages.
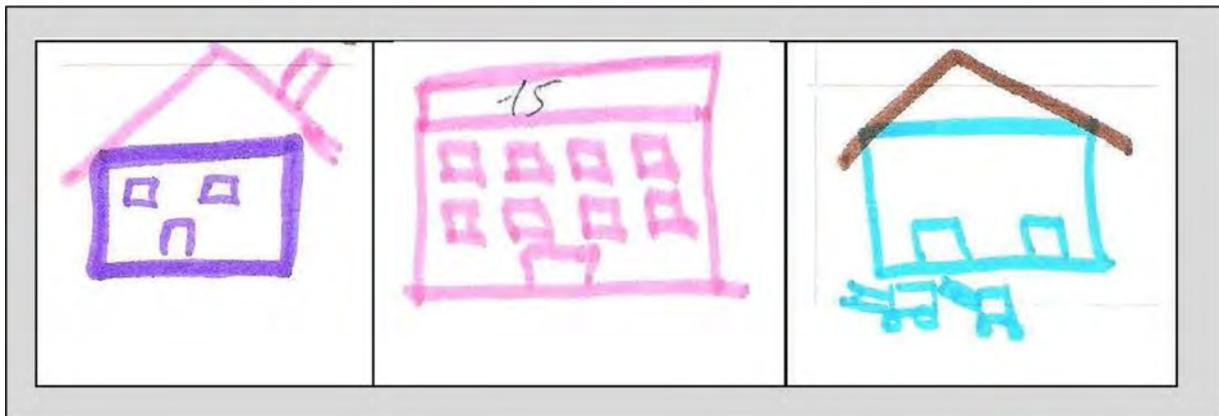

Figure 17: The use of visual variables of size and salient features (market's trolley) to depict different types of buildings.

Subjects also used – supplementary to effective communication of meaning – the visual variable of color. Specific attributes of objects have been coded in colour as one of the affordances of the graphic mode to portray reality in an alternative and comprehensible way. Colour contributes to the process of meaning making by eliciting correspondent associations to the viewer (Tyner, 2010) and therefore initiates cognitive procedures that enhance symbol understanding.

Generally speaking, individuals' symbols tend to maintain consistency in cartographic style. Roads, for example, are mainly depicted as grey lines (straight, curved, discontinuous) in different combinations (parallel, single; cf. fig. 10).
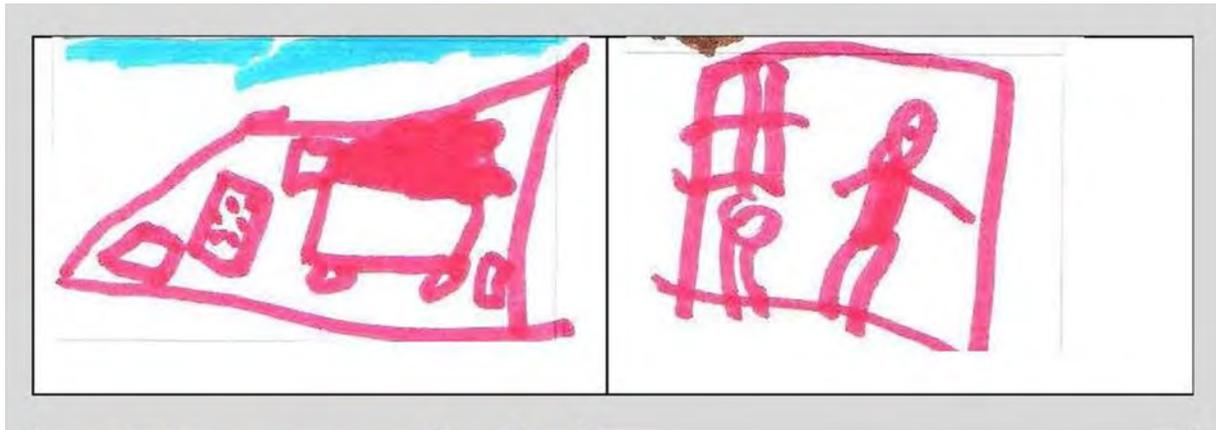
Figure 18: Transparency in signs of market and school.

Children's cartographic signs are indicative of drawing qualities defined by developmental psychology (e.g. transparency; cf. fig. 18). Furthermore, concerning sex variation, girls were more concerned with color use and detailed designs, whereas boys preferred single colour sketches (fig. 9.1) and outlines (fig. 12).

It has been observed that children invented – in analogy with language – expressive equivalents. For example, they used the visual attribute of pattern (repetition of identical design) in order to depict a plural form (trees), which was used in the verbal mode to express plurality in the visual mode (fig. 11). Apart from several representations of a single tree (fig. 3&4), the cartographic sign of trees has been depicted by means of two or more identical or slightly different trees in line (where the line served as ground; cf. fig. 2) or variously distributed in the given design space (fig. 11). "Hence, when children draw, they construct and interpret a range of verbal and non-verbal signs with reference to the conventions associated with this medium of communication" (Wright, 2008).

However, comparative analysis of data provides evidence on visual competency acquired through learning and planned instruction. Preschoolers, after being explicitly taught the cartographic principles of design and being exposed to cartographic signs during teaching intervention, create symbols, which demonstrate a degree of similarity to signs that have been exposed, observed and recorded. The degree of iconicity is decreasing gradually being substituted by more conventional, abstract signs (symbols) that have been learnt in a systematic teaching procedure (fig.15). Conventions should be taught through explicit analysis of structural characteristics and visual attributes of graphic design in order to be learned and consequently integrated into individuals' designs. Teaching interventions should be of a long duration and organized in units of progressive difficulty (Wiegand, 2006) in order to entail positive results.

The coexistence of both symbolic and iconic signs in a considerable amount of children's designs (42%) was assumed to be indicative of a transitional developmental stage from realistic to more symbolic representations. Subjects' preference for icons seems to reflect the developmental and cognitive stage of preschoolers according to which pictorial and naturalistic representations of reality are assimilated and accommodated better than abstract ones and simultaneously refrain from misinterpretations. Maturity factors and experience through systematic learning of the function of semiotic resources play a central role in the development of abstract thinking and symbolization.

During the current research, preschoolers produced cartographic signs out of a mapping context. Generally, context provides readers of a specific genre with adequate information, which supplements and enhances meaning that is derived by its prospective

readers. Hence, in future repetition of this research it would be proposed to allow preschoolers to insert the symbols they have created in a map context so as to estimate their functionality in a real meaning context. Medynska-Gulij (2008) claims that "full assessment of symbol design can only be made after an analysis of their relationship with the visual variables of the remaining context".

Finally, a qualitative assessment of children's cartographic designs is considered to be an appropriate method. However, for better estimated results the sample should be extended and content analysis of children's discourse, concerning their oral descriptions and justifications of their designs, should be conducted. In addition, qualitative analysis of children's designs should be enhanced with more than two codes (symbolic and iconic signs). The dual coding of data may had narrowed the field of research, while the exclusion of other categories (geometrical, pictographic, etc.) that previous research indicates presumably could enhance results' reliability and breadth.

The current research attempted to draw evidence on young children's meaning making of cartographic signs and usage of visual variables to produce meaning. Such cumulative knowledge might be applied to generate appropriate learning activities that enhance preschooler's literacy in visual and graphic semiotic modes and finally contribute to more effective communication.

6. References

Aanstoos, J. (2003). Visual literacy: an overview. *Applied Imagery Pattern Recognition Workshop, 2003. Proceedings.* (pp. 189 – 193).

Anderson, K. C., & Leinhardt, G. (2002). Maps as Representations: Expert Novice Comparison of Projection Understanding. *Cognition and Instruction*, *20*(3), 283–321.

Atkin, A. (2010). Peirce's Theory of Signs. *he Stanford Encyclopedia of Philosophy.* http://plato.stanford.edu/archives/spr2012/entries/peirce-semiotics/

Babbie, E. R. (2011). *The Basics of Social Research.* Belmont: Cengage Learning.

Bertin, J. (2011) Semiology of Graphics: Diagrams, Networks, Maps. Redlands: Esri Press.

Casti, E. (2006). Towards a Theory of Interpretation: Cartographic Semiosis. *Cartographica: The International Journal for Geographic Information and Geovisualization*, *40*(3), 1–16.

Catling, S. (2005). Developing children's understanding and use of maps. In K. E. C. Lee & C. H. Chang (eds.), *Primary Social Studies: Exploring Pedagogy and Content.* Singapore: Marshall Cavendish Education.

Catling, S., & Willy, T. (2009). *Teaching Primary Geography (Achieving QTS).* Exeter: Learning Matters.

Cope, B., & Kalantzis, M. (2000). Multiliteracies: the beginnings of an idea. In B. Cope & M. Kalantzis (eds.), *Multiliteracies: Literacy Learning and the Design of Social Futures.* New York: Routledge.

DeLoache, J.S. (2002). The symbol-mindedness of young children. In W. W. Hartup & R. A. Weinberg (eds.), *Child Psychology in Retrospect and Prospect*, Minnesota Symposia on Child Psychology (vol. 32), pp. 73–101. Mahwah, New Jersey: Lawrence Erlbaum Associates Inc.

Deloache, J. S. (2004). Becoming symbol-minded. *Trends in cognitive sciences*, *8*(2), 66–70.

DeLoache, Judy S., & Sharon, T. (2005). Symbols and Similarity: You Can Get Too Much of a Good Thing. *Journal of Cognition and Development*, *6*(1), 33–49.

Downs, R. M., Liben, L. S., & Daggs, D. G. (1988). On Education and Geographers: The Role of Cognitive Developmental Theory in Geographic Education. *Annals of the Association of American Geographers*, *78*(4), 680–700.

Feinstein, H. (1982). Meaning and Visual Metaphor. *Studies in Art Education*, *23*(2), 45–55.

Filippakopoulou, V., & Nakos, B. (2009). Children and Mapping. (R. Kitchin & N. Thrift, eds.) *International Encyclopedia of Human Geography*. Oxford: Elsevier.

Goria, S. (2007). *Visual literacy in early childhood education: A project with the use of maps* (Unpublished Master thesis). Volos.

Goria, S., & Papadopoulou, M. (2008). Preschoolers Using Maps: An Educational Approach. *International Journal of Learning*, *17*, 117–127.

Hardy, M. A., & Bryman, A. (2004). *Handbook of Data Analysis*. London: Sage.

Keates, J. S. (1996). *Understanding Maps*. Harlow: Longman.

Koch, W. G. (2011). New conceptions of iconicity and its significance in the semiotic interpretation of cartographic symbols. *Proceedings of the 25th International Cartographic Conference*. http://icaci.org/files/documents/ICC_proceedings/ICC2011/

Korpi, J., & Ahonen-Rainio, P. (2010). Cultural Constraints in the Design of Pictographic Symbols. *The Cartographic Journal*, *47*(4), 351–359.

Kynigos, C., Yiannoutsou, N., Dimitrakopoulou, A., Ioannidou, I. (2001). *Children in Choros and Chronos.* European Commission DG XIII, Esprit LTR, Experimental School Environments, Responsible Partners: University of Athens, University of Aegean, Computer Technology Institute, C3 Project Deliverable D.1.4 – Final Evaluation Report.

Lysaker, J. T. (2006). Young Children's Readings of Wordless Picture Books: What's 'self' Got to Do with It? *Journal of Early Childhood Literacy*, *6*(1), 33–55.

MacEachren, A. M. (2004). *How Maps Work: Representation, Visualization, and Design*. New York: The Guilford Press.

Medynska-Gulij, B. (2008). Point symbols: Investigating principles and originality in cartographic design. *The Cartographic Journal*, *45*(1), 62-67.

Myers, L. J., & Liben, L. S. (2008). The role of intentionality and iconicity in children's developing comprehension and production of cartographic symbols. *Child development*, *79*(3), 668–684.

Namy, L., & Waxman, S. (2005). Symbols redefined. In L. L. Namy (ed.), *Symbol Use and Symbolic Representation: Developmental and Comparative Perspectives* (pp. 269–277). Mahwah, New Jersey: Lawrence Erlbaum Associates Inc.

Neytchev, P. (2008). The Cartographic Knowledge Base in Formulating the Linguistic Trends in Map Semiotics. *Geographija*, *44*(2), 75–82.

Nöth, W. (2003). Semiotic foundations of the study of pictures. *Sign Systems Studies*, *31*, 377–392.

Peralta de Mendoza, O. A., & Salsa, A. M. (2003). Instruction in early comprehension and use of a symbol–referent relation. *Cognitive Development*, *18*(2), 269–284.

Racine, N. J. (2002). *Visual Communication: Understanding Maps, Charts, Diagrams, and Schematics*. New York: Learning Express.

Rakoczy, H., Tomasello, M., & Striano, T. (2005). How children turn objects into symbols: A cultural learning account. In L. L. Namy (eds.), *Symbol Use and Symbolic Representation: Developmental and Comparative Perspectives* (pp. 67–97). Mahwah, New Jersey: Lawrence Erlbaum Associates Inc.

Rambaldi, G. (2005). Who owns the map legend? *URISA Journal*, *17*, 5–13.

Robinson, A. H., Morrison, J. L., Muehrcke, P. C., & Kimerling, A. J. (1995). *Elements of Cartography*. Hoboken: Wiley.

Rød, J. (2004). Cartographic Signs and Arbitrariness. *Cartographica: The International Journal for Geographic Information and Geovisualization*, *39*(4), 27–36.

Sharon, T. (2005). Made to Symbolize: Intentionality and Children's Early Understanding of Symbols. *Journal of Cognition and Development*, *6*(2), 163–178.

Sluter, R. (2001). New Theoretical Research Trends in Cartography. *Revista Brasileira de Cartografia*, *53*(1), 29–37.

Thomas, G. V., Nye, R., & Robinson, E. J. (1994). How children view pictures: Children's responses to pictures as things in themselves and as representations of something else. *Cognitive Development*, *9*(2), 141–164.

Tolar, T. D., Lederberg, A. R., Gokhale, S., & Tomasello, M. (2008). The Development of the Ability to Recognize the Meaning of Iconic Signs. *Journal of Deaf Studies and Deaf Education*, *13*(2), 225–240.

Tyner, J. A. (2010). *Principles of Map Design*. New York: Guilford Press.

Unsworth, L. (2001). *Teaching Multiliteracies Across the Curriculum: Changing Contexts of Text and Image in Classroom Practice.* Buckingham: Open University Press.

Wiegand, P. (2006). *Learning and Teaching with Maps.* London, New York: Routledge.

Wright, J. K. (1962). Review: The Language of Geography: Review. *The Geographical Journal, 128*(1), 71–73.

Appendices

Appendix A: Design sheet

Appendix B: *Comparative analysis of design outcomes of the pre and post test*