Linguistics and Education xxx (2013) xxx–xxx

Contents lists available at ScienceDirect

Linguistics and Education

journal homepage: www.elsevier.com/locate/linged

Construing geometric shapes in a language literacy context: Defining and classifying triangles in Greek kindergarten

Paraskevi Giannisi*, Marianna Kondyli[1]

Department of Science of Education and Early School Education, University of Patra, Panepistimioupoli Rio, GR 26500 Patra, Greece

ARTICLE INFO

Available online xxx

Keywords:
Classification
Definition
Geometric shapes
Greek kindergarten
Literacy
Systemic Functional Linguistics

ABSTRACT

Some findings deriving from a wider research concerning Greek kindergarteners' definitions and classifications of geometric shapes are presented in this paper. Our theoretical framework as well as research tools draws from the sociosemiotic approach of Systemic Functional Linguistics, according to which the use of linguistic resources activates meaning systems assumed to be relevant to specific learning contexts. In order to examine how young children make use of their linguistic potential, we set up a learning context related to language literacy pedagogy such as the production of a "book about geometric shapes" intended for other preschool children. Interactions between children and their preschool teacher have been analysed so as to illustrate semantic options relevant to the semantic organisation of geometric, uncommonsense knowledge categories.

1. Introduction – theoretical framework

Familiarising pupils with the discourses of various disciplines constitutes the principal endeavour of school education. If literacy is defined as participation in learning practices of various discourses through semiotic systems involving written language (Hasan, 1996), then school is the institution where such practices in fields of uncommonsense knowledge (Painter, 1999b) are applied. First school literacy constitutes a crucial milieu for the connection of everyday experience and commonsense knowledge with uncommonsense knowledge fields. In other words, it is a favourable area for the development of semiotic processes underlying *the re-shaping of human experience* (Halliday, 1999).

From a sociosemiotic perspective, our categorisations of things/entities, that is to say our everyday as well as more specialised classifications, are produced through semiotic processes within social contexts and by socially situated subjects, negotiating meaning or producing new meanings, mostly through language. The semiotic potential of lexicogrammar enables us to form categories of meaning, that is to say ways to conceptualise the social, inner and external world. From this language-based approach to learning, language learning is interrelated to the attainment of socially constructed knowledge, to the socially mediated linguistic means of giving meaning to experience (Halliday, 1999).

School knowledge, although actually formed through the dialectical relationship between oral and written language, is based on written language and targets systematic/uncommonsense knowledge (Halliday, 1996, pp. 353–354). In this sense, "*it is rather doubtful that the ability to engage in educational discourses could develop naturally without experience of the educational processes*" (Hasan, 1996, p. 398). Previous experiences and language resources, developed through children's participation in less formal learning contexts, still constitute the basis for school learning. Recognising and utilising children's

* Corresponding author. Tel.: +30 2610 997 796; fax: +30 2610 997 796.
E-mail addresses: giannisi@sch.gr (P. Giannisi), kondyli@upatras.gr (M. Kondyli).
[1] Tel.: +30 2610 997 796; fax: +30 2610 997 796.

0898-5898/$ – see front matter © 2013 Published by Elsevier Inc.
http://dx.doi.org/10.1016/j.linged.2013.08.001

potential and background is, in fact, the only option for teachers, especially on the entrance of children into the education system, in order for different contexts and contents of learning to be "scaffolded".

Painter's insightful studies (Painter, 1996, 1999a, 1999b, 2007) into linguistic development and learning in the early years of a child's life (2:5–5 years of age) and her sociosemiotic approach of analysis paved the way for the focus of our investigation. Following the theoretical framework of Systemic Functional Linguistics (SFL), Painter's (1999a) case study on spontaneous everyday interaction shed light on the semiotic mediation grounded in verbal interactions between children and adults and stressed the continuity of family literacy processes and the ways in which they are connected to systematic/educational literacy. Her conclusions also made clear that engagement in classifications and definitions, namely the familiarisation with some "*specific semiotic processes*" (Hasan, 1996, 2005a), constitute the appropriate linguistic preparation for the transition to educational/uncommonsense knowledge (Painter, 1999b).[2]

Based on the above theoretical framework, our research assumes that the development of semiotic processes such as definitions and classifications related to the construction of knowledge of geometric shapes, implies the linguistic realisation and negotiation of their meaning within suitable teaching settings and meaningful contexts of action. More specifically, the study of classroom interaction can illustrate aspects of the ways in which *geometric shapes* are construed by kindergarteners, shedding more light on the linguistic-semiotic construction of an ordinary area of school knowledge. Moreover, such studies can support the assumption that a structured school literacy context encourages the development of specific semiotic processes, such as generalisation, classification and definition, considered to be fundamental for the development of school knowledge. (For related studies in Greek kindergarten, see Douka, 2003; Kondyli & Archakis, 2004; Kondyli & Lykou, 2008).

We have not noticed previous research concerning young children's realisations within contexts of early mathematical knowledge from a linguistic perspective. An exception is, however, to be found in the paper of Mohan and Slater (2005) which addresses issues of 6–7 year-old children's reasoning in a ESL science class under the overt instruction of their teacher, in order to create a (simple) theory of magnetism. In their research they adopt a linguistic perspective (SFL), so as to provide evidence of the language-based approach to teaching and learning. Our study could be seen as a complement to Mohan and Slater (2005) work insofar as it investigates linguistic realisations of kindergarten pupils, albeit with a different *literacy pedagogy*: (a) less teacher-centred, mainly focusing on the interaction between children, so as to construct a common understanding of geometric shapes, and (b) a language literacy approach – even if the area we are focusing on technically speaking belongs to maths literacy. Moreover, it should be noted that, since the material and/or semiotic basis of science literacy (observation of experiments) differs from that of geometry, the respective semiotic processes are not all that similar.

We should also note that in the case of the Greek kindergarten, despite the claim of Interdisciplinary Common Curriculum Framework for Kindergarten (D.E.P.P.S., 2003) about the *cross-curriculum character* of language, the sociosemiotic nature of the language, as well as the role of verbal interaction still remains obscure. It is worth mentioning that the *basic concept* of "System-classification" is mentioned in all other areas (*Mathematics, Environmental Studies, Creativity and Expression, Computer Science*) but not in *Language*. Our investigation aims to illustrate the language and learning relationship in literacy processes, including that of geometry. In our case, instead of following a typical to early maths literacy sequence of geometric tasks, we provided a language-based literacy project (a book about geometric shapes), in order to fully adopt the cross-curriculum character of *D.E.P.P.S.*

On the basis of the sociosemiotic perspective about the systematic and dialectical relation among context-meaning-grammar (Hasan, 2005a), we made the following assumptions:

- Given that the relation between semantic and lexicogrammatical choices is one of *realisation*, the analysis of the dialogues – emphasising on the linguistic realisations of the children themselves – allows us to study the semantic choices made by groups of children as language users within the field of research (semantic organisation of an uncommonsense area of knowledge).
- In their developing semantic system, such as that of uncommonsense knowledge, children are expected to use meanings they have constructed on the basis of their *previous experiences* (everyday and/or school literacy contexts), considered to be relevant to this particular context.
- However, given that *the context itself* directs children towards specific choices, elements concerning the organisation of the suggested teaching setting are in fact structural parts of the situation, crucial for children to construe meaning and therefore, for their linguistic choices as well.

The above assumptions formed the framework for the literacy pedagogy adopted in our research. In the paper, evidence about the ways in which language is constructed in areas of uncommonsense knowledge in the Greek kindergarten is provided. More specifically, data concerning classifications and definitions of triangles are presented.

[2] The claims above recontextualising Vygotsky's theory (1978) of sociogenesis of thought and of social mediation in the construction of "higher mental functions" on the one hand, and Bernstein's theory (1990) about differences in contexts and uses of language (contextualised/decontextualised) on the other in connection with the distance from the immediate experience and the material basis of their production, are specified in the theoretical model of Systemic Functional Linguistics (SFL). (For the discussion about the interconnection of Vygotsky's, Bernstein's and Halliday's ideas and on the dialectic relationship between the social and the semiotic, see Hasan, 2005b).

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The data about triangles come from a wider corpus of kindergarten classroom interactions during a series of activities involving a range of shapes (triangle, square, rectangle, rhombus, circle, and ellipse) – therefore including the relation and differentiation of the specific representatives of the triangles' category from the members of other shape categories with hyponymy or whole/part relations (for examples of taxonomic lexical relations see Unsworth, 2001, p. 67; Martin, 1992, p. 295). However, the conclusions drawn from data concerning triangles are indicative of the ways in which kindergarten children classify and produce definitions and reinforce the general assumptions of this paper.

2. Methodological framework

2.1. Organisation of the research–teaching setting

In accordance with our theoretical framework, our research–teaching setting and the activities related to it involved organising a meaningful context as a condition of re-contextualising children's existing knowledge of the specific semantic fields (the categories of geometric shapes). More specifically, children's involvement with geometric concepts was set within a scenario frame of action: the production of books, which were to be sent to schools that could not afford to make such a purchase, due to lack of funds (this action was proposed on the occasion of the International Children's Book Day). The activities were implemented by the one of the researchers, who was also the teacher of the particular class (a suburban state kindergarten in Athens, lower class children). Emphasis was placed on the linguistic negotiation of meaning and the operational integration of classification and definition tasks in the process of text production concerning geometric shapes.

In the research we included the older pupils of the class (12 girls and 6 boys, aged 5:6 to 6:3), who attend the (recently applied by law) compulsory year of kindergarten (about 5–6:5 years old). Children worked together with their teacher in small groups of three (2 girls and 1 boy) in their everyday school classroom and during the period between April and May of the 2008–2009 school year. Each group undertook the task of creating a book about geometric shapes as well as an insert card game of geometric shapes. The book to be produced was described from the outset as a "learning book" (i.e. an informative leaflet/dictionary of "basic terms") for children. In this case, the knowledge of geometric shapes was considered to be a precondition for the pupils to play the card game found in the book. The whole project was carried out during the successive meetings of each group, and was divided into activity modules, coherent and consistent with each other, according to the original context of the project (the production of the book), and, partly, to the level of their difficulty (the extent to which they had to use decontextualised semiotic resources and dissociate from the material basis of the project). Our corpus consists of 20 video and tape recorded meetings (about 13 h in total).

The general objectives of each meeting's tasks were clearly explained at the beginning of the session. The teacher participated in the discussion as a coordinator, asking open, general questions, related to the aim of each activity. Special attention was paid to ensure that the teacher would not direct the children's answers but encourage the discussion between the members of each group. The adopted teaching strategy (teacher as "discourse guide") could be comparable to "exploratory talk on children's understanding" adopted by Mercer and Sams (2006), although their research does not follow a linguistic but a wider Vygotskyan perspective.

In brief, the tasks of all the groups included the following activities:

(A) **Classification of flat geometric shapes** which would be pasted on the pages of the book after discussion and agreement between the members of the group (36 non-identical paper geometric shapes of the same colour and texture, with variations within each category regarding the shape qualities and size of the shape). At first, all shapes (circles, ellipses, triangles, squares, rectangles, rhombuses) were laid out on the work table in no specific order. The children were asked to place the shapes on the table in a distinctive way – so that every member of the group could see them – and then come to an agreement about the final classifications. The teacher did not mention any shape names unless they had been previously used by children and she simply repeated their wording. Some of the shapes (circles, triangles, squares and rectangles) had been presented to the children at the beginning of the school year, mostly through introductory activities carried out in sessions where the whole class was present.

(B) **Addition of texts**: Assigning "titles" to every shape category (***categorisation by naming***) as well as producing informative texts for the reader (***definitions, exemplifications of their categorisations***), which were dictated to the teacher.

(C) **Creation of a card game** (a deck of 27 cards of 4 basic shapes: circle, triangle, square, rectangle) after the completion of phase B and a sample performance in a meeting with the entire class. In order to redesign the card shapes, each group collected objects found in the classroom and classified them according to their shape (drawing the outline of the selected objects' facets).

(D) **Presentation of the books** with the participation of the pupils of another kindergarten class and playing of a **description game** (a child picks a card from the deck and describes the shape depicted on it to the rest of the pupils, who try to identify it).

The whole project presupposed (a) collaboration so that a common target (the production of the book) could be achieved (b) linguistic negotiation in order for an agreement to be reached (strategies of meeting the requirements of each phase of the project) and (c) linguistic interaction as a means of composing the book's content. We considered that including activities which direct children to handle objects in an immediate way could facilitate the participation of all the pupils. Therefore,

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activities more closely connected to the material basis of the situation, such as the task of classifying paper geometric shapes, could be carried out by giving language a rather "auxiliary" role, invariably related to the main purpose of action. On the other hand, the production of texts, following the first classifications (discussion on the categories of shapes in the book), involved reflection over meaning and encouraged more decontextualised speech ("constitutive" role of language) (e.g., Martin, 1992). Thus, the continuum from the act of categorising objects to the production of definitions and informative texts should be seen as the "semiotic space between action and reflection" in which various degrees of abstraction are produced (Martin, 1992, p. 513, 522).

2.2. Research tools

Drawing on the model provided by Systemic Functional Linguistics (SFL), our analysis focuses on children's linguistic realisations in connection with the realisation of **relational clauses**, i.e. in connection with elements of the **transitivity system**, associated with the ways of experience representation. Relational clauses encode meanings of "being" and of "having", meanings which we use when we identify experiences, co-relate parts of experience or attribute characteristics to it.

At lexicogrammatic level, relational clauses are realised by the use of verbs/processes, nominal groups (the Participants) and optional circumstantial elements (adverbial groups or prepositional phrases). The Participants are symbolically linked to each other by **identifying** or **attributive** relations, through relational verbs such as "be" and "have", but also through a great number of other verbs and verbal phrases like "turn into", "become", "look like", "go with" "match" (Halliday & Matthiessen, 2004). Furthermore, the relationship among entities can be **intensive** (x *is* a, where "a" is a quality/identity of "x" or "x" is a member of "a" class), **possessive** (x *has* a) or **circumstantial** (x *is at/because of* a etc. – stating place, manner, cause, companionship, angle, etc.). In identifying relational clauses the Participants are the ***Token*** and the ***Value*** – e.g. *She* (Token) *must be Mary* (Value)/*Olympus* (Token) *is the highest mountain of Greece* (Value). In attributive relational clauses the Participants are the ***Carrier*** (the object of description/classification) and the ***Attribute*** – e.g. *Mary* (Carrier) *is a teacher* (Attribute)/*Circle* (Carrier) *doesn't have corners* (Attribute) [the underlined words indicate the Participants].

Because of the teaching/learning situation and the age of the children, one of our assumptions was that intensive identifying clauses of *Token* and *Value* type, which can be characterised as definitions *per se*, were not likely to be formed (see Kondyli & Lykou, 2008). In our corpus, the clauses that could mainly be considered as identifying ones are those realised through metalinguistic processes, such as *to call* ("is called/we call it a"). Attributive clauses were preeminent in our data.

In order to specify further the semantic choices made by groups of children, we also examined the Participants of relational clauses or complexes of relational clauses in relation to some aspects of the **Mode** variable, which is concerned with the textual organisation of information and meaning. Emphasis was placed on **taxonomic relations** which refer either to **class/subclass** superordination **(hyponymy)** relations "of being" (e.g. flower-rose) or to compositional **part/whole (meronymy)** relations "of having" (e.g. flower-petal) (Unsworth, 2001, pp. 66–68; Martin, 1992, p. 295; Halliday & Hasan, 1989).

During the initial classification task, hyponymy relations could be linguistically realised by children even with the use of a single word naming a shape. The use of shape names was examined for its consistency with the categories of the material and in terms of their consistent use by the members of the same group of children during a meeting as well as across meetings.

Regarding cohesive devices of textual meaning we also examined:

(a) **The structure of Nominal Group** (NG): Emphasis was placed on uses of embedded phrases or clauses, which can follow the name (Head), modifying its meaning from both logical (subordination) and experiential view, reformatting aspects of experience through rankshifting. Such qualifiers may shift circumstantial information in NG structure (e.g. shoes [[that slip]]) or classify the adjunct name construing subclasses (e.g. shoes [with laces]) (Halliday & Matthiessen, 2004).
(b) **Types of reference**: Related Participants can be either *phoric* or *non phoric* (Martin, 1992, p. 98). Phoric NG are realised by definite deictics presuming a Participant's identity. Participant's identity can be specified by reference to context (homophoric reference), to situation (exophoric reference) or to the text itself (endophoric reference). Non-phoric NG present or introduce participants and are realised by indefinite articles and pronouns or a noun in plural without other deictics. The latter case is related to different degrees of abstraction in a polarity continuum from closely contextualised to more decontextualised linguistic realisations. It should be noted that in Greek, generic reference can be realised by definite article, either in single or in plural and wording can be ambiguous (Holton, Mackridge, & Philippaki-Warburton, 1999, p. 275). Thus, meaning is closely interrelated to the situation.
(c) **Causality and conditional structures:** In our material, textual indexes, like the use of conditional or time-temporal conjuncts appear in complexes of relational clauses.

From a wider perspective, we can consider children's attempts to produce a more decontextualised speech for the identification of a shape category, when they no longer deal with specific objects/shapes but with the meaning of the category (e.g. generic reference of shape name, causality and conditional structures), as realisations of definitions within the particular learning context. The emphasis on the distinctive features of the triangle category, the formulation of hyponymy relations

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Table 1
Specifying shapes as typical samples of the category.

That's how *Carrier:* Circumstantial adverb of manner as a participant (exophoric reference)	*triangles* *Attribute* (participant: Class)	*are* *Relational process:* Intensive attributive

Table 2
Affirming class.

All *Deictic:* Quantitative	*these* *Carrier:* Exophoric reference	*are* *Relational process:* Intensive attributive	*triangles* *Attribute* (Class)

through the correlation of two shape categories on a different level of semantic organisation,[3] the correlation (comparison and contrast) of two categorical terms of shape in the same relational clause or in a complex of relational clauses (linguistic realisation of geometric relations), as well as more complex descriptions (e.g. in complexes of attributive relational clauses) could be seen as more directly connected to more formal definition contexts.

3. Findings

In the following section we present the main findings concerning children's collaborative attempts to define triangles focusing on: (a) the semantic strategies implemented in order to identify and classify triangles, the more geometrically relevant parameter of spatial transformations included; (b) the lexicogrammatic realisations of different kinds of definitions, in correlation with the specific demands of each task. The latter point, although not fully undertaken in this paper, is of great interest, since it resonates the variation of children's realisations in relation to the specific register of each phase.

3.1. Identification of shape

3.1.1. Hyponymy relations

Naming any entity constitutes in itself an act of linguistic categorisation (Painter, 1999a, p. 129). As was expected, during the initial categorisation of flat paper geometric shapes at the first meeting (phase A) children identified the material by naming the shapes (names of categories). The act of naming separate shapes-objects or groups of shapes-objects could emerge either as a spontaneous comment or as a reply to a relevant question asked by the teacher, and was realised either with the use of a single word or through complete relational clauses (with or without simultaneous exophoric deixis).

Our data reveal that the use of the name "triangles" was significantly consistent in all groups and during all meetings, since there were no instances of confusion with other names or the need for being reminded or corrected by the other members of the group (which, in fact, occurred in the case of rectangles, squares and rhombuses). Furthermore, the name "triangle/-s" corresponded to the relevant shapes of the category in our material. Thus, out of the six groups which participated in the teaching-research setting, five agreed on a common classification of all triangles in phase A, while the sixth group (Group 5) formed distinctive subgroups of triangles, not being able to decide between their alternative classifications. In fact, in the case of Group 5 triangle classifications were an object of constant negotiation based on various criteria. However, in phase B, children suggested the number of sides, that is, a formal geometric property, as a criterion for triangle identification.

The use of category name is more frequently linked to the context in phase A, where the task mainly demanded material action, and the criteria of how the particular category is distinguished from the others often remained non-verbalised. Thus, in phase A name reference (triangle/-s) basically pertains to a non-linguistic context (exophoric reference for present entities, endophoric reference for present entities which had been previously indicated). Nevertheless, even at this phase we can identify linguistic realisations which indicate a more conscious way of dealing with material shapes as members or typical samples of a category, such as in examples 1 and 2 and their corresponding Tables 1 and 2 [about the realisation of the quantity-deictic "all" and the deictic "this/these" in Greek, see Holton et al., 1999, pp. 296, 307–8, 310].

In the following examples, the group of children (Gr1, Gr2, etc.) and the phase of the project (A, B, C, D) are included in a parenthesis. In the extracts of dialogues the children are referred to with their initials and the teacher with the abbreviation (Tch). Information pertaining to the context is put in brackets [], comments on linguistic features in curly brackets {}; and the omission of text is symbolised with (. . .).

1. (Gr1A)
F.: *That's how triangles are* {=*That's what triangles look like*}
[raising a triangle and presenting it as a typical member of the category]
2. (Gr1A)
K.: *All these are triangles* [holding all the triangles as members of the category before putting them in an envelope]

[3] The use of two noun categories of different taxonomic levels within the same relational clause construing an hyponymy relation such as in the example "a platybus is an animal" appears, according to Painter (1999a, p. 102), at the forth year of age. For linguistic realisations of classification and identification by children of 2:6–5 years of age through relational clauses and complexes of relational clauses, see Painter (1999a), chap. 3 – briefly Tables 3–5, p.127.

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In our data some identifying clauses[4] also appear realised by metalinguistic verbs ("they are called", "to call them", "we can call it" "it is called"), which are used by children in order to illustrate the connection of the name (category term) with the members of the category (example 3) or classify certain triangles (right-angled triangles), which children regard as marginal members of the category or as possible subcategories of the basic one (example 4).

In the latter case, due to their unawareness of an appropriate term, children of Group 5 successively suggest various names, which they draw from correlated entities of another class by focusing each time on specific category representatives (the 2 right-angled scalene triangles or the right-angled isosceles triangle). The naming of right-angled triangles as "shark's fin/-s" or "pyramid/-s" is used here as a text convention, in order to classify these specific shapes according to the requirements of the project. It is worth noting that, besides Group 5, the correlation of right-angled triangles to "a shark's fin" also appears in Group 1 (examples 5 and 6). Furthermore, some extratextual indications (e.g. which triangles were classified first and which were added afterwards), as well as relevant discussions within all groups offer us considerable clues that the two right-angled scalenes are related primarily to each other and secondarily to the rest of the triangles. This implies their inclusion to a lower level of semantic organisation (subcategory) or treating them as marginal representatives of the triangle category.

3. (Gr5A)
X.: *This* [she looks at a triangle from the classroom shape chart, which included 4 representations of shapes – circle, isosceles triangle, square and rectangle – as well as their names; during the discussion, the children looked for the table which was put up in another part of the classroom and used it as a resource of information about all shapes] *is called a triangle and goes with the triangles* [looking at the research triangles].

4. (Gr5A)
X.: *These*. . . *these somewhere*. . . *I don't remember what they are called* [looking at a page with right-angled triangles](. . .)
X.: *I think they could be called pyramid* [meaning "pyramids"]. *You?* [addressing E.] {Representatives as members of a category}
(. . .) E.: *That's how a shark's fin is. We can call it a shark's fin* [referring to the shape category as a whole].

5. (Gr1A)
[A spontaneous comment made just when the shapes were placed on the table]
F.: *This*, [right-angled triangle] *normally, no, when it's like this* [upright position of right angle] *it looks like a shark's fin*.

6. (Gr1 C)
F.: *Kids, this* [right-angled scalene triangle] *looks like the shark's*.

3.1.2. Construing part–whole relations

Investigation of part–whole relations of shapes through notional intersections or side designing (extension of sides and/or jointing of vertexes) was another strategy that the children employed in order to examine the shapes. In the case of Group 3, drawing imaginary intersections on all shapes constituted a basic strategy for the production of their texts during phase B. This strategy seems to emerge from the assumption (expressed in phase A) that a rhombus could be formed by intersecting a square. This very idea was then (phase B) extended and applied to all shapes, especially to triangles produced by a diagonal intersection on rectangles ("in the middle, a line like that"), which children tried to further specify by using everyday vocabulary (e.g. "slanting", "pointed"). In this case, the relational clauses construe meronymy relations connecting different categories of shapes (geometric relations) through realisations which embed circumstantial elements in NG structure, using time-conditional conjunctions as well as material verbs (e.g. "we cut"). The modal "can/could" also appears in children's speech. Such realisations do not simply assign an attribute, but also create causality relations, stating either a condition (obligation statement) or a possibility (prediction of an event's sequence) (cfr. Painter, 1999a, p. 139). In our data, the following examples are indicative of such realisations:

7. (Gr3B)
K.: *Miss, I got it. If we cut them here* [she points to a rectangle], *the rectangles will turn into slanting triangles*.
Tch.: *Yes, but how shall we cut them?*
K.: *Like this, in the middle, something like that, in the middle, a line, like that* (. . .) [she draws an imaginary diagonal]
M.: *When we cut this here* [she moves her finger through a rhombus on the page], *it'll turn into a pointed triangle*.
(. . .) K.: *We can also cut it like this* [she draws an imaginary diagonal on a square] *and it turns into a triangle*. (. . .) *We can write: If we cut in the middle, to turn into a triangle*.
Tch.: [repeats while writing] *If we cut*. . .
M.: . . .*in the middle*
K.: . . .*could turn into a triangle*.

8. (Gr1B)
[F. claims that triangles are related to letter "n" {in Greek "v"}; K. runs and fetches his name card, where "v" appears, and shows it to F.]
K.: [he shows "v" on the card] . . .*because here, if it is closed, it will be a triangle*.

Construing of part–whole (mostly half-whole) relationships constituted one of the criteria for contrasting triangles (right-angled scalene, right-angled isosceles) as well as triangle and other shape categories (rhombus and, by extension, in some cases, square). Nevertheless, the comparison of shapes seems to lead to different conclusions by the members of the same group of children. In the following extracts from groups 5 and 2, the right-angled scalene triangles are considered either

[4] According to Kondyli and Lykou (2008), such verbal processes in Greek kindergartens appeared only in the teacher's speech. However, we should note that this study focused on teacher–pupils interactions in sessions with the entire class present (see also Douka, 2003; Kondyli & Archakis, 2004).

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elliptical triangles (example 9) or not triangles at all (example 10), since, when they are compared to isosceles triangles, part of the shape is missing.

9. (Gr5B)
[Discussion on the titles of the pages with shapes previously agreed on; reconsideration of the issue of common classification of acute and right-angled triangles, which had been classified and put on separate pages in phase A]
E.: *I say (they are)* [refers to right-angled triangles] *triangles because they look like triangles a bit, but they look like* (. . .) *a ruler.*
X.: *Yes, but look!* [points successively to the two pages illustrating triangles] *Their line should be a bit longer in order to be a triangle. I think we should change them, to put them in different groups, not together.* (. . .)
X.: *I don't think we should put them together* [comparison of 3 acute triangles and 3 right-angled triangles]. *I don't agree, because they are not the same. That is, the triangle should have a line a little bit longer, a triangle has a long line, but this* [right-angled scalene] looks like a shark's, the thing on its back. . . [she addresses the teacher, first pointing to the biggest acute scalene on the one page and then to the right-angled scalene on the other page, which she imaginarily completes with a hand movement extending the base line of the triangle]

10. (Gr2A)
[The children are putting the shapes they agreed on into envelopes; G. refuses to put some triangles in the envelope]
E.: *That. . .Look, it is a triangle, but here they haven't made another. . .* [points successively to bases of a right-angled scalene and of an isosceles]
G.: *Yes, but you know what, it doesn't look like a triangle!* (. . .) *It's half of it too!* [he compares the two triangles placing the right-angled on top of the isosceles – the former is half of the latter in size] *It pulls in half, so it shouldn't. . .*
(. . .) Tch.: [to G.] *What should it have to be a triangle?*
G.: *It should have this* [points to base line of the largest isosceles triangle] (. . .) *but it doesn't match with this* [points to a right-angled triangle] *because this is half.*

In the same way, the relation between triangle and rhombus constituted a matter of discussion for most groups. For instance, the fact that G. suggested the common classification of triangles and rhombuses, possibly due to their acute angles, led to the specification of the classifying criterion by M.:

11. (Gr2A)
M.: *I think that they are not in the same group because this is like this and that is like this* [she draws the outline of a triangle and rhombus with her hand]. *That is, this has three angles. . .this has one, two, three, four.*

The correlation of the two categories on the basis of the common characteristic of acute angles was the starting point for focusing on their contrasting qualities too, as well as for construing meronymy type relationships. The dialogue extracts from groups 1, 2 and 4 are typical of this:

12. (Gr1A)
Tch.: *What have you put here K., which shapes have you put there?*
K.: *Er, triangles and rhombuses.*
Tch.: *Will you make one group or separate groups?* [the two shape groups on the table are very close to each other]
T.: *One.*
F.: *Separate, separate, I think. Rhombuses don't go with triangles.*
K.: *They do!* (. . .) *They do, they do, because we have. . . it pricks here, it pricks here, it's the same here too* [he points successively to the vertexes of some rhombuses and triangles]
F.: *Yes, but we mustn't. . . yes, but they are not the same!*
K.: *No, they aren't, but they are (. . .)*
F.: *They don't look alike, normally.*
K.: They look alike a bit (.) these ones. . . [he holds a rhombus up and touches its vertexes]
Tch.: [to T.] *What do you think?*
T.: *They don't look alike, they don't.*
F.: *These ones, these are two triangles stuck together, not stuck, it's the rhombus. This is a triangle, isn't it?. . . and one more triangle on the bottom* [she raises a rhombus and shows the two tangent sides to the other children; then she turns the rhombus upside down and shows its other two sides] (. . .) *and that's how it turns into a rhombus. That's only one triangle* [she shows a triangle from K.'s groups].

13. (Gr2A)
[Every child holds the "agreed" members of one shape category in order to place them in separate envelopes; G., who has taken triangles, repeats his initial argument about the correlation between triangles and rhombuses]
G.: *This is M's.* [he picks a triangle out. M. has the rhombuses]
(. . .) Tch.: *Is it a rhombus, dear?*
G.: *Yes, it's a rhombus.*
M.: *No. Can I see?*
Tch.: *Does it look like this?*
M.: *Well, it doesn't have such a thing, it isn't. . .* [she puts a triangle next to a rhombus and points to the piece missing in order to be a rhombus]

14. (Gr4A)
Tch.: *Yes, how can we distinguish it* {endophoric reference: triangle} *from the other shapes?*
Z.: [she takes a page with the shapes pasted on it] *Because the triangle has one line from the (. . .) but a rhombus has two.*
Tch.: *So, what can we write? Explain to me, what shall I write now?*
Z.: A *triangle has no other* [she draws a crooked line in the air (Λ)/half a rhombus].
A.: *A triangle has 3 lines not 4.*

3.1.3. Spatial specification of shape identity

In our data the identification of each shape category was also realised in relation to their specification (conservation or change of the shape's identity) according to their location, or spatial transformations – mainly rotation (cfr. Clements &

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Table 3
Construing causality.

[[If/When we turn it this way]]			*Modifier: Embedded phrase*				
If/when	*we turn*	*it*	*this way*	*it [triangle]*	*will be/ will turn into*	*α triangle*	*(again)*
Time-conditional conjunction	*Material process*	*Goal of material action*	*Circumstantial: space*				
		Token			*Identifying relational process*	*Value*	*Circumstantial: time*

Sarama, 2009). In these cases, the children's action during the tasks is accompanied by comments connected to the objects' identity, as in the following dialogue:

15. (Gr2A)
[While the children were pasting shapes on the pages]
G.: *Oh, I put it upside down!*
E.: *It's still. . . it's still a triangle.*

In many cases everyday words ("upside down", "upright", "slanting") are used as shape modifiers, sometimes implying a prototype position of the shape. In children's linguistic realisations in our data the term "slanting" seems to be the most ambiguous. Different groups of children used this term in order to describe mainly right-angled triangles (but also rhombuses), when trying to specify the type of triangle (most likely based on their acute angles) or to distinguish it from the most typical (school) form and position of triangles (usually isosceles triangles with their acute angles facing upwards). In examples 16, 18, 19 the relevant position of the shape (modifiers "slanting", "upside down") is used as a classifying attribute. The term "slanting" is repeated by the same child of group 3 in a following meeting classifying right-angled triangles formed by the intersection of squares (example 17) and rectangles (about rectangles, see example 7).

16. (Gr3A)
Tch.: *All these are. . .* [triangles which have been grouped and put all together]
K.: *The triangles and the . . . some slanting triangles* [right-angled triangles].

17. (Gr3B)
M.: *I mean. . . Let's say these are scissors* [a pencil] *and I cut it a bit like this* [she points to a diagonal on a square]. *What does it turn into?*
K.: *A slanting triangle.*

18. (Gr1B)
T.: *Yes. If we turn it this way?* [she holds and rotates a triangle] *It turns into a. . .?* [with interrogative intonation – expecting an answer]
K.: *No, it turns into. . . a little, one angle. . .* [hesitates while he compares it to the angle of another triangle]
F.: *No, it's a slanting triangle.*

19. (Gr1B)
T.: *Miss*, [addressed to F.] *pass it to me – if we turn it this way, what does it look like?* [she turns around a page with triangles and shows it to the teacher – the base side of the isosceles is put horizontally and the acute angle is facing downwards]
Tch.: *The others can't see this way. . . which way? Like that?* [she turns the page T. holds so that it faces the rest of the children]
F.: *It's. . .* [thinking]
T.: *It's an upside down. . .*

Statements like those in examples 18 and 19 ("it's a slanting triangle", "it's an upside down. . .") are closely related to material processes ("turn"), when the spatial specification (shape location) is examined as a shape definition variable. Adopting a rather school-type question/answer communication scheme, children realised complexes of relational clauses in a complementary way. The use of time-conditional questions in the *Carrier* position within the relational clause is also interesting. The same time-conditional structure lies within some other relational clauses like the ones in example 20, which, however, are uttered as a pure statement and are relevant to the conservation of the shape identity. The spatial determination is treated here as an identifying characteristic of the shape. Such clauses more clearly express not only a situation-based inference, but also a potential condition (conservation of the shape's identity in every change of its location). Thus, the specific clauses refer to the potential generalisation of the context (see also the use of the first plural person of the verb "turn" as well as the use of "again" in the sense of repetition and constancy of shape identity) (Table 3).

20. (Gr1B)
F.: *If we turn the triangle like this* [she rotates the page with the pasted triangles – the acute angles put horizontally] *it turns into a triangle again.* (. . .)
T.: *If/when* {in Greek άμα: time-conditional conjunction} *we turn it this way, it will still be a triangle* [she rotates the page] (. . .) *Here, write down what we've said.*
Tch.: *Say it.*
T.: *If/when we turn it this way too, it will turn into a triangle again.*

3.2. Realisations of definitions

Apart from the examples of realisations of definitions, which appear in shape identification above, we should refer to some further data, which are directly connected to the production of definitions.

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Table 4
Attributing distinctive features.

A triangle	has	three	angles
Carrier: Indefinite article + name	Relational process: possessive attributive	Modifier:	Attribute
Omophoric reference (class)		Numeral	

Regarding the use of superordinate terms specifying the taxonomic relations, the term *shape* is extensively employed by children on various occasions. In phase B, however, it is sometimes embodied in their suggested texts – mostly at the beginning – with relational clauses, linking the basic level category ("triangle") to the hypercategory "shape" through a hyponymy relation. In the following clauses, the category – "title of the page" is meant to be the Participant of the relevant informative texts. Interestingly enough, the realisations here are related to the introduction of patterns used in other kind of texts (riddles – example 21) or to direct projection of the didactic character of the text (example 22).

21. (Gr4B)
It's a shape and it has 3 angles. Do you know which shape it is?

22. (Gr2B)
It's a triangle, to help you learn the shapes.

As was expected in line with our assumptions, children's attempts to construe a definition appear mainly in phase B (text production) with realisations referring omophorically to the class of triangles, as in the example of Table 4:

The Carrier ("A triangle") in the example above refers to the wider cultural context [omophoric reference]. The particular phrase was drawn from the dialogue below (the underlined parts constitute the *nominal groups* of relational clauses):

23. (Gr1B)
Tch.: [the teacher shows a page with triangles – all shape category pages are on the table] *How can we distinguish a triangle? What does it need to be a triangle?*
F.: *Three angles* [response without pointing]
Tch.: *What shall I write then?*
F.: *That a triangle has three angles* [without pointing]
K.: . . .*and three lines!* [without pointing]
Tch.: *That's correct!*
F.: *And it doesn't look that much like . . . and it's a little bit like a rhombus, because it. . . because a rhombus has two triangles* {intensive attributive and possessive attributive}.
(. . .) Because they look a bit alike and you need to put two triangles together.

The above procedure reoccurs in other groups' discussions about defining triangles as well. Thus, in example 23, kindergarteners F. and K. produce a definition together ("*a triangle has three angles and three lines*"). Moreover, the task assigned to them ("how can we write it, in order to make others understand?") seems to induce the children to use further information concerning the relation of triangles to another shape category (rhombus), on the basis of similarity. In fact, this correlation ("*and it's a little bit like a rhombus (. . .), because a rhombus has two triangles*"), as well as the particular phrasing, are not randomly chosen, since the text clarifies the relationship between triangle and rhombus, recontextualising the conclusion drawn from a previous group discussion about the relationship of the two shapes based on their common characteristics (example 12).

Furthermore, definitions of a different type appear in phase B of the project (production of written texts about shapes), through correlation with familiar entities. In this case children assign attributes by connecting the name of the shape with "school type" entities (depictions of letters, depictions of objects found in books of shapes) or with objects of everyday experience, more frequently boat sails or house roofs. This strategy for formatting the book's text in the case of Group 1 was further elaborated by the children, who in addition, specified the conditions of similarity. In this case (example 24), the spatial specification of the shape in the structure of NG and the use of verbal group "it's like" (meaning "looks like") in attributive relational clauses is typical (Table 5).

Table 5
Attributing conditions.

If we put a triangle upright						
If	*we put {we make it}*	*a triangle*	*upright {adjective}*	*it*	*is like*	*lamda*
Conditional conjuction	*Material process*	*Goal of material action*	*Modifier: Position*	*Endophoric reference*		
	Non phoric reference Carrier				*Attributive relational process*	*Attribute*

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24. (Gr1B)
Tch.: *What shall I write?*
F.: *That, if we turn a triangle upside down (. . .), it is like a small (lowercase) "ni"* {vocalisation of the Greek letter "ν"}
(. . .) Tch.: *If it is closed, said K., it will be a triangle. Do you all agree?*
F.: *Yes. Can I say something else? If we put a triangle upright, it is like lamda* {vocalisation of Greek letter "Λ"}, *but there is a difference because. . . because it has a line at the bottom.*
(. . .) but it is different because it has a line lying.

Treating triangles as a semantic category and as a quality of objects is obvious in examples 25–27, where children are speaking about the category using objects as examples of the specific shape. In the example from Group 6 (25/Gr6B) the embedded phrase (EP) *[[which looks like a triangle]]* constitutes an attributive relational clause, functioning as a qualifier of the noun (cheese). In the same way, the phrases *like when we cut the cake/when it looks like this, we can eat it* embody in a NG structure (rankshift) information from relevant contexts. In example 26 from Group 1, the shape quality (*triangular*) is inserted into the NG structure as a classifier for *kite*. The EP [[*which looks like a roof*]] is used differently (27/Gr5B). Here, the EP is supplementary to the clause identifying the shape category (non phoric reference) and illustrates the notion through an example of the shape.

25. (Gr6B)
A.: *The triangle looks like the. . . that cheese [[which looks like a triangle]], [[like when we cut the cake, and when it looks like this we can eat it]] (. . .)*

26. (Gr1B)
F.: *Triangles are like a triangular kite.*

27. (Gr5B)
E.: *It's the triangle [[which looks like. . . roof]]. And the roof is triangular.*

Correlations like those in the examples from phase B are instances of descriptive definitions, functioning as explanations for the supposed reader. Moreover, they are almost absent from shape identifications in phase D (description game with cards of four (4) different shapes). Here, the children use terms which are related to more formal qualities of the shape, like "angles"/"lines" (referring to the sides), which had been mentioned and construed as characteristics of the objects in previous meetings. The linguistic realisations focus on the contrast between triangle and other shape categories through inclusive *possessive clauses*, as in the following examples:

28. (D)
F. (Gr1): *It has 3 lines and 3 angles.*
A. (Gr4): *It has 3 angles.*
M. (Gr2): *It has 3 angles, it looks like a pyramid.*

4. Conclusions – discussion

In our research we investigated how a structured literacy framework, in which small groups of kindergarten pupils were involved, activated their potential to construe and verbalise categories of geometric shapes. During the classification tasks and the production of informative texts by the groups, children used their linguistic potential, making specific choices in order to identify and to give some definitions of the triangles.

The name *triangles* was used consistently and to a large extent by all groups and during all their meetings. The name of the shape {τρίγωνο} seems to have assisted children, since the fact that it is a compound word (τρί [three]–γωνο [angle]) functioned as a reminder of a basic quality of the shape. Thus, there was no category overlapping in any of the triangle classifications performed by the groups.

All the groups ascribed more typical characteristics to the shape (*angles*, "*lines*"). Moreover, there were also attempts related to the mathematical conceptualisation (e.g. comparison of shapes by measuring sides and angles). However, the reflection on similarities and differences among the various representatives of triangles also encouraged children to use everyday language terms in order to construe subcategories (*shark's fin, pyramids* for right-angled triangles) or specify particular characteristics (*slanting/pointed/upside down triangle, lying down line*). The spatial position of the shapes, as a possible variable concerning maintenance or change of the shape identity (rotation and change of the position of the shape), as well as the construing of part–whole relations were also employed as strategies for identifying triangles.

Classifications were grounded on direct observation, comparison and contrast between both members of the same category (different representatives of triangles) and members of different shape categories. The realisation of relational clauses is related to children's attempts to examine shapes' qualities as identifying and/or classifying criteria. The study of the total corpus of each group shows that the verbalisation of meaning does not concern stable, irreversible or of the same kind criteria, but issues introduced for further discussion and negotiation.

The construing of criteria on the basis of the considered similarities (e.g. acute angles in rhombuses and triangles) or differences (e.g. attributing a half-whole relation between right-angled scalene and right-angled isosceles triangle) also caused, as was expected, confusion and disagreements within the groups. Such disagreements and their dynamics, observed in some of the extracts quoted here, constitute an issue needing further investigation that would go beyond the scope of this paper. Nevertheless, our data shows that the various positions which were adopted by the children were basically linked to

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their decisions and the strategies they employed in order to construe the meaning of the context, as well as to carry out the task they had been assigned (the production of a book about shapes).

It is also evident from our data that children's investigation of the semantic organisation of shapes goes beyond the immediate and specific demands of the material classification, and becomes part of a more conscious attempt to produce definitions. So, despite the direct and expected close relation between relational clauses and circumstantial elements, especially in phase A, in many cases children's linguistic realisations show a more conscious involvement in specifying the meaning of the category (names in plural without pointing, generalisation deictics like *all* etc.). Their attempt to develop a more decontextualised language is also evident in complexes of relational clauses (see spatial determiners and analysis–synthesis of shapes), where circumstantial elements are embodied in NG structure realising causality (circumstance as a condition – obligation statement – or as a possibility – prediction of an events sequence). (Cfr. Painter, 1999a, pp. 127, 133–135, 173–175; for more examples of generalisation indicators and causality structures in relational clauses realised by children regarding all shape categories of our corpus, see also Giannisi & Kondyli, 2012).

As was expected, the development of definitions is more clearly realised in phase B through complexes of relational clauses or paratactic linking of attributive relational clauses, in order to state shape qualities. Such definitions are basically descriptive and constitute the outcome of processes of synthesis of opinions stated by different children of the group or the outcome of recontextualisation and summary of previous positions.

Moreover, children's realisations depend on how they construe the meaning of text production in relation to the tasks of each phase. Thus, the school-type character of the book seems to be taken into consideration by the children in phase B, leading them to make use of their knowledge of written language. In several cases, children used relevant class books as a source of information, (mainly utilising their pictures – shape samples and depictions of everyday objects). Moreover, correlations with familiar objects as examples of the category abound in the children's linguistic productions, especially in phase B, which should be considered as descriptive definitions (For a more extended presentation of the various semiotic systems (e.g. alphabet, numbers, geometric concepts) and resources of information (e.g. everyday objects and their semantic taxonomies, relevant printed material, different text types) utilised by children in order to create their books, see Giannisi & Kondyli, 2011). The didactic purpose of such definitions and the children's attempt to respond to the specific demands of the task in each phase are made apparent through their choices during description game in phase D, where few references to familiar objects can be found. Here the children use terms related to more formal characteristics of the shape (*angles, lines*), considering them to be the most appropriate for the specific task, although their meaning does not clearly resonate formal geometry conventions. This kind of different strategies according to the designed tasks stresses the importance of the specific contents of class activities and the role of context for the assessment of children's performance.

Our findings on the development of definitions could be linked to the perspective of teaching genres, although this was not the target of this research. Our results could indeed be correlated with the general view of genres as social processes concerning, in our case, the development of describing and explaining genres (e.g. Unsworth, 2001) and the early attempts of the participating kindergarteners to produce informative texts.

Some other findings of our research, related to the specialised construing of mathematic notions and mathematic literacy, are of interest too (see e.g. Koleza & Giannisi, 2013; Maier & Benz, 2013). However, the correlation and comparison of our findings to conclusions of typically mathematical oriented approaches of geometric shapes goes beyond the aims of this research. Nonetheless, our data supports our basic assumption that a meaningful context of literacy pedagogy, without direct and open instruction, allows children's involvement in definitions and classifications, and that linguistic realisation and negotiation of meaning do activate the existent knowledge of children promoting reasoning processes combined with the learning of uncommonsense knowledge categories.

Acknowledgements

We would like to thank the referees who, with their useful comments of an earlier version of this paper contributed to an improved result. Also, thanks go to Christopher Lees for his meticulous copy-editing of this paper.

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