

Teaching pre-school Mathematics and influences by the kindergarten school social context: A preliminary study

GERASIMOS KOUSTOURAKIS, KONSTANTINOS ZACHAROS,
KONSTANTINA PAPADIMITRIOU

Department of Educational Sciences
and Early Childhood Education
University of Patras
Greece
koustourakis@upatras.gr
zacharos@upatras.gr
kpadimitriou@upatras.gr

ABSTRACT

The empirical material of this preliminary study was drawn from the recording and analysis of teaching activities used during the implementation of the new pre-school Greek curriculum in sixteen classes of public kindergartens. More specifically, according to the opinion of the kindergarten teachers about the social backgrounds of the majority of their students, 8 kindergartens belonged in a middle-class social context and 8 in a working-class social context. Research findings showed variations in the pedagogical practices in those two types of kindergartens. Variations were observed in the choices made by pre-school teachers in the development of mathematical knowledge in the classroom, in the ways that teachers and students interact during the teaching process, in the organization of the classroom, and in the application of evaluative rules and teaching strategies for teaching mathematics.

KEY WORDS

Mathematics school knowledge, pedagogic practices, preschool education, social context

RÉSUMÉ

Le matériau empirique de cette étude préliminaire a été élaboré à partir de l'enregistrement et l'analyse des activités d'enseignement utilisées au cours de la mise en œuvre du nouveau programme grec préscolaire en seize classes des écoles maternelles publics. Plus précisément, selon l'opinion des enseignants de la maternelle sur les origines sociales de la majorité de leurs élèves, 8 écoles maternelles appartenaient dans un contexte social de la classe moyenne et 8 dans un contexte social de la classe ouvrière. Les résultats des recherches ont montré des variations dans les pratiques pédagogiques dans ces deux types d'écoles maternelles. Variations ont été observées dans les choix faits par les enseignants du préscolaire dans le développement de la connaissance mathématique dans la classe, dans la façon dont les enseignants et les élèves interagissent pendant le processus d'enseignement, dans l'organisation de la classe et dans l'application des règles d'évaluation et stratégies pour l'enseignement des mathématiques.

MOTS-CLÉS

Connaissances scolaires de mathématiques, pratiques pédagogiques, éducation préscolaire, contexte social

INTRODUCTION

School curricula are created by the actions of dominant socio-economic and groups within a specific historical period, expressing their interests and ideological goals in shaping the consciousness of students as citizens of tomorrow (Young, 1998; Apple, 2000). The teaching of academic subjects, however, is influenced by the teacher and his or her educational practices, so there may be small or large differences between the intended curricula and the implemented curricula (Bernstein, 1990; Apple, 2002). Sociological research suggests that existing variations in applied pedagogical practices may be due to the influence of the students' social backgrounds while attending a particular class (e.g. Holland, 1981; Dowling, 1998; Hoadley, 2007, 2008); differential distribution of school knowledge to the students of different social classes has been observed (Bernstein, 1991; Morais, 2002).

An important area of research is the study of pedagogical choices made by mathematics teachers in primary or secondary education, as well as the analysis of the content of mathematical curricula and the official mathematical school knowledge (Morgan, Tsatsaroni & Lerman, 2002; De Abreu & Cline, 2003; Hoadley, 2007, 2008; Koustourakis & Zacharos, 2011).

Research findings about preschool mathematics education are focused on several key areas: students' comprehension of mathematical concepts, the effectiveness of

teaching techniques, the implementation of problem-solving practices, and the use of educational software in order to develop mathematical skills of young children (e.g. Baroody & Tiilikainen, 2003; Cassey, Kersh & Young, 2004; Clements, 2004; Clements & Sarama, 2009). The research also addresses the effect of teachers' personalities in formulating how they plan to teach preschool mathematics (e.g. Zacharos et al., 2007), and the countervailing impacts of socio-economic backgrounds and family environments in the learning process (e.g. Starkey, Klein & Wakeley, 2004; Bodovski & Farkas, 2007). Studies of mathematical education in Greek kindergartens have generally investigated the influence of family backgrounds on the ability of young children to perceive and comprehend mathematical concepts and to examine the effectiveness of specific teaching strategies (e.g. Chronaki, 2005; Skoumpourdi, Tatsis & Kafoussi, 2009; Zacharos, Antonopoulos & Ravanis, 2011). Little research has taken place, however, that analyses the issues related to pedagogical practices for teaching mathematics at the kindergarten level. The purpose of this research, therefore, is to investigate the effect of the social context in shaping pedagogical practices during mathematical teaching in Greek kindergarten classrooms.

In this study, we employ the theories of Bernstein (1990, 2000) on the "pedagogic code", and the theories of Dowling (1996, 1998) on strategies for teaching mathematical. Further, from Hoadley's model (2007, 2008) we derive instructional forms that refer to ways of organizing the classroom context during teaching.

The structure of this paper is as follows. First, we summarize the current mathematics curriculum found in Greek preschool education. This is followed by a discussion of the theoretical framework, research questions and methodology. The final section presents the research findings, and concludes with a discussion of these findings and conclusions.

The curriculum of mathematics in Greek preschool education

Curriculum reform in Greek kindergartens took place in 2003. Reform was driven by the decision of European leaders in Lisbon 2000 to modernize the education system and to contribute to the creation of a knowledge society (Alahiotis & Karatzia-Stavlioti, 2006). The curriculum developed for pre-school education seeks the active participation of young children in discovering and constructing school knowledge. The proposed teaching methodology advocates a cross-thematic approach to knowledge; preschool teachers shape the daily schedule of their teaching activities by combining knowledge from other school subjects taught in the of pre-school curriculum. Those subjects are Language, Mathematics, Environmental Study, Creativity and Expression, and Informatics (Ministry of National Education, 2003).

The new curriculum encourages young children to systematically participate in the educational process through organized sets of mathematical activities, thus leading to enhanced mathematical knowledge (Ministry of National Education, 2003; Dafermou,

Koulouri & Mpasagianni, 2006). It also enhances the flexibility of preschool teachers in developing a plan for teaching mathematical concepts, including , “what” will be taught, “how” it will be taught, “in which order”, and the allocation of teaching time dedicated to a given mathematical concept.

The following mathematical concepts comprise the curriculum in in Greek preschool education: a) the identification, naming and classification of basic geometric shapes, b) the presentation and creation of symmetrical shapes, c) comparisons and measurements of geometric figures, d) the familiarization with mathematical relationships, such as associations, classifications and the arrangement of objects in space, e) the introduction arithmetical concepts, and multiplication and division by using mainly specific objects, and f) the introduction of young children to problem-solving practices (Ministry of National Education, 2003).

THEORETICAL FRAMEWORK

Sociological research has shown (e.g. Bourdieu, 1986; Bourdieu & Passeron, 1990) that students from middle-class homes seem to be more comfortable in communication compared to children from working-class families; the cultural capital implicitly required by the school is part of their personality. Middle-class students may also know and use the language code which corresponds to the school’s language. Therefore, they easily meet the demands and expectations of teachers (Bourdieu & Passeron, 1990; Bernstein, 1991). Moreover, an important differentiating parameter among pupils at school is the “orientation to meaning” (Bernstein, 1971; Holland, 1981; Hoadley, 2007). This refers to the ability of children to perceive things and situations in ways that allows them to communicate complex concepts and ideas. This enables them to disconnect their minds from a need for direct contact with everyday things and events. Holland (1981) showed that the acquisition of early contextualizing experiences by children, affects positively their understanding of school knowledge. Family environment plays an important role in the composition of these experiences. Parents who belong to middle-class contexts enable their children to develop context-independent meanings. This context benefits their children, who can then understand more easily the knowledge taught in school, including the more esoteric domains¹ of mathematics. In contrast, their classmates from working-class contexts do not possess those advantages (Dowling, 1998, 2002). Students from working-class contexts are usually oriented in context-dependent meanings and understand better the mathematical school knowledge that utilizes elements from their everyday experience, where this knowledge is presented an in an

¹ The esoteric domain “refers to the region of an activity which is most classified with respect to other activities. Both forms of expression and content are specialized” (Dowling, 1998, p. 136).

experiential manner (Dowling, 1998, 2002). Therefore, it appears that students from working class contexts find it more difficult to understand the specialized knowledge and abstract meanings required by school mathematics (Holland, 1981; Hoadley, 2007, 2008; Lerman, 2010).

Bernstein's theory (1990, 1991, 2000) on the "pedagogic code" utilizes the concepts of "classification" and "framing". This helps us to approach and analyze the type of school knowledge taught to students, and the diverse pedagogical practices used for this purpose. Such practices are influenced by the social-class context of students who attend a particular class.

The concept of "classification" refers to the degree to which the contents of a given subject are insulated from other subjects taught within the overall curricula. Where classification is strong (C^{++} , C^{+}), clear and distinct boundaries exist between the different subjects, easily distinguishing one from the other. Strong classification also implies strict adherence to a particular scientific field, which, in the case of school mathematics, is shaped by the recontextualization of elements from the specialized language and the scientific practices of mathematical science. In cases where boundaries between different curriculum subjects are blurred, the classification is weak (C^{-}) and school knowledge is formed by a combination of cognitive elements drawn from different scientific areas (Bernstein, 1991, 2000).

"Framing" (Bernstein, 1991, 2000) helps to identify the type of hierarchical rules that apply during teacher-student interactions at the micro-level of a classroom. Framing also identifies options available for teaching school knowledge (e.g., sequence and selection, pacing and evaluative rules). In the case of strong, framing hierarchical rules (F^{+}), teaching is focused on the transmitter, and student choices are limited. Conversely, in the case of weak framing of hierarchical rules (F^{-}), teaching is focused on the acquirer and allows a large degree of autonomy to the student to reach out and conquer school knowledge. In kindergarten, framing of hierarchical rules is strong (F^{+}) when the teacher is highly directional during teaching and leaves no room for students to act alone and conquer knowledge. Moreover, strong pacing indicates that the rhythm of teaching is fast and the kindergarten teacher doesn't offer adequate time for the students to acquire process and understand mathematical knowledge. The framing of evaluation rules is strong (F^{+}) when the teacher gives clear instructions and guidance to students about what result is expected and acceptable by the educational process, and thereby helps them to recognise and correct their mistakes and misunderstandings.

Dowling (1998, 2002) uses Bernstein's theory in school mathematics, delineating two basic teaching strategies: 1) the 'localizing mathematical strategies', which use knowledge derived from the empirical world of students to teach mathematics, and 2) the 'specializing strategies', which use knowledge drawn from within the field of mathematics. Localizing strategies include three types of teaching actions: i) 'nominal

tasks' – the naming of mathematical symbols or mathematical objects, ii) 'ritual tasks' – student participation in ritual activities, such as the repetition from the whole class of a classification of some things in space, under the guidance of the teacher, and iii) 'mechanical tasks' – the realization of activities of a mechanical nature activities, such as copying a number from the board or colouring a drawing with mathematical content. In the case of specializing strategies, we distinguish two cases of teaching activities: i) 'procedural tasks' where students carry out simple mathematical processes such as the classification of geometric shapes, or writing a mathematical symbol, and ii) 'principled tasks' where complex, mathematical operations are conducted, where students have to think and choose between different alternatives applying certain mathematical rules, justifying their choices and solving problems.

The analysis model of pedagogical practices on school mathematics teaching, introduced by Hoadley (2007, 2008), is also a useful construct in regards to how the classroom is organized. Utilizing the concept of instructional forms from Pedro's theoretical framework (Hoadley 2008), the organization of the classroom for teaching mathematics is analysed as follows: i) 'homogenous', when the teacher works together with all the students in the class, ii) 'integrated', where students work in groups, and iii) 'specialized', when the teacher is working particularly with some students or with a group of students.

Inquiring questions

The main research question in this paper is as follows. Are the existing practices for teaching mathematics in Greek kindergarten classrooms differentiated according to their social context, as it is perceived by the kindergarten teachers? Corollary questions for research include:

- i. What is the form of school mathematics taught/transmitted by teachers in Greek kindergarten? That is to say, are mathematical activities a separate teaching subject or are they integrated into a cross-thematic approach?
- ii. What are the didactic/interactive relationships between kindergarten teacher and pupils in the teaching of mathematics?
- iii. What teaching strategies are applied by kindergarten teachers for teaching mathematics, and how did they organize their classroom for this purpose?

METHODOLOGY

The sample

The research was conducted in 16 public kindergarten classrooms in the city of Patras (Greece). The categorization of schools as being of middle-class social context or working-class social context was based on the kindergarten teachers' opinions who

work in the specific kindergarten schools. Specifically, eight kindergarten schools in the inner city area were selected, in which, indeed, the distribution of parental occupations were predominantly middle class. Eight other schools were selected from poorer neighbourhoods of the city where parental occupations were predominantly working class (Holland, 1981). The organization of the school was generally similar in all kindergartens since this issue is managed by the applicable preschool curriculum (Ministry of National Education, 2003). Kindergarten students in this research had an averaged five years of age, and most were Greek. A few students had foreign parents, though the students were born in Greece and spoke Greek fluently.

Preschool teachers in the selected kindergartens held a bachelor's degree from a 4-year college, and averaged about fifteen years of teaching experience. In addition, the teachers had attended a training program on the content and objectives of the new preschool education curriculum, which was officially implemented in the 2006-2007 school year.

Because these schools voluntarily participated in the internship programs of the Pedagogical Department of the University in that city, preschool teachers and students in the surveyed classes were familiar with the frequent presence of other persons in their classrooms.

Collection and processing of empirical data

The collection of research data proceeded according to a participative observation framework (Cohen, Manion & Morrison, 2004). The observation of each class lasted an entire teaching week (5 days) during which a weekly cycle of formal application of the curriculum was completed (Dafermou, Koulouri & Mpasagianni, 2006). Researchers stayed in the classroom, observed and recorded the educational process from beginning to the end, and recorded the teaching practices used. There was no explanatory directive given to the teachers, because our intention was to observe the actual daily pedagogical practices applied in the particular schools. For this purpose, our observation included all that was taught in the kindergarten during a school week.

The research material formed by the daily teaching activities was approached through the method of content analysis. As a unit of analysis, we took the task-unit of analysis (Hoadley 2007, 2008), which is a complete instructional activity that has a specific teaching goal associated with a very specific teaching topic. One such topic is the presentation of a geometric shape, complete with its characteristics and properties. The various units of analysis were classified into each of the categories of analysis, which are displayed in the Table I, each being independent, complementary and supportive. Collectively, they help to compose an image of pedagogical practices implemented in schools for teaching mathematics.

TABLE 1

Pedagogical practices for teaching mathematics: categories of analysis	
Classification	<p>C^{++}: school knowledge derives solely from the science of mathematics.</p> <p>C^+: mathematics is taught as a separate subject, but during the teaching of other subjects is also used to help infants understand mathematical concepts.</p> <p>C^-: mathematical content knowledge is also offered to students while being taught other subjects in the curriculum.</p>
Framing	<p><i>Hierarchical rules</i></p> <p>F^+: teacher-centred teaching method. F^-: student-centred teaching method.</p>
	<p><i>Pacing</i></p> <p>F^+: teaching is fast-paced, and strict time frames are followed for teaching mathematics. F^-: adequate time is available to students to understand school mathematical knowledge.</p>
	<p><i>Evaluative rules</i></p> <p>F^+: criteria for assessing mathematical knowledge are clearly defined. F^-: criteria for assessing mathematical knowledge are not clearly defined.</p>
Instructional strategies	<p><i>Localizing mathematical strategies</i></p> <p><i>Nominal strategies</i>: naming of mathematical symbols and mathematical objects. <i>Ritual strategies</i>: repetition and imitation by infants of the mathematical actions suggested by the teacher. <i>Mechanical strategies</i>: teaching activities of mechanical character, such as copying numbers from the board and painting a drawing with mathematical content.</p>
	<p><i>Specializing strategies</i></p> <p><i>Proceduralizing strategies</i>: simple mathematical activities. These activities are accompanied by clear instructions. <i>Principling strategies</i>: knowledge of mathematical rules is required along with reasoning, justification, or explanation ability, as well as novel applications of knowledge.</p>
Classroom context organization	<p><i>Homogenous</i>: preschool teacher works with all students in the class.</p>
	<p><i>Specialized</i>: preschool teacher works with some students to help them understand mathematical concepts.</p>
	<p><i>Integrated</i>: all students are working in groups.</p>

Task units were classified by the researchers into the categories of analysis listed above, corresponding to two periods, one month apart. More specifically, a task unit was included in a certain analysis category as long as it was classified in it at least three times (the acceptable percentage of agreement being > 75%) (Vamvoukas, 2002; Koustourakis & Zacharos, 2011).

FINDINGS

Classification

Table 2 presents the results of total task units with mathematical content in the

TABLE 2

Total task units with mathematical content in both school social context categories

Classification Teaching School mathematics	Task units with mathematical content by school context	
	Middle-class social context N (%)	Working-class social context N (%)
C ⁺⁺	55 (52.4)	20 (28.2)
C ⁺	18 (17.1)	22 (31.0)
C ⁻	32 (30.5)	29 (40.8)
Total task units	105 (100.0)	71 (100.0)

two types of school categories along with the classification of school mathematical knowledge. By studying the data for total task units, it can be seen that a greater number of teaching activities with mathematical content were conducted for middle-class context schools (105 task units over 71 task units for the working-class social context of kindergartens).

Moreover, the teaching choices of preschool teachers in the two categories of schools differed in the shaping of mathematical knowledge ($p \leq 0.01$). In both categories, teachers sought mainly to teach mathematics as a separate subject (C⁺⁺ and C⁺), although this was accomplished in a different ways (middle-class schooling context: 73 task units, 69.5% - working-class schooling context: 42 task units, 59.2%). More specifically, in schools of middle-class social context, teaching activities with absolute mathematical content prevail (C⁺⁺: 55 task units, 52.4%). Extract I is a typical example that shows the prevailing teaching activities in the middle-class schooling context.

The preschool teacher introduces counting quantities and addition to the children

T (Teacher): How many are the boys in our team?

S (Students): Eight.

T: And how many are the girls?

S: Ten.

T: And how many are you all, boys and girls?

Children counted themselves, and then were asked to find from a set of numerical cards the one showing their correct, identifying number.

Extract I Example C⁺⁺, from middle class social context

In working-class social context of kindergartens, the teaching of mathematics as a separate and independent subject is conducted using activities that connect mathematical knowledge with knowledge of other subjects (C⁺: task units 22, 31.0%).

Qualitative analysis showed this knowledge being derived from language, creativity and expression. In this category of kindergartens, we realised the importance of the teachers' efforts to provide knowledge of mathematical character to students via the teaching of other subjects in the curriculum (C: 29 task units, 40.8%), as in the case of Extract 2. In this example, for the curriculum subject 'environmental study', the teacher recites the months of the year, thus providing to the students' knowledge of both mathematics and language (through recognition of letters in the alphabet).

Here the teacher introduces the order of numbers, indicating the sequence of the months of the year

T: Look here [points to a board where cards with the names of months were hanged].

We have the months in order. First, second, [...], twelfth. Which is the twelfth month, the last one, when we also have Christmas?

An infant shows the twelfth month.

T: What is its first letter?

Students: It's "D".

Extract 2 Example C⁺⁺, from working-class social context

To summarize, in the classification category we found that kindergartens in working-class areas made efforts to connect mathematical concepts with the knowledge of other subjects in the curriculum (C⁺, C⁻); an attempt at cross-curricular teaching of school knowledge. This conformed to the official pre-school curriculum instructions, which as a main teaching method proposes the interdisciplinary approach to scientific articles (Ministry of National Education, 2003; Dafermou, Koulouri & Mpasagianni, 2006). In contrast, for middle-class context kindergartens, the majority of preschool teachers deviated from the new curriculum guidelines by teaching mathematics as a subject that has its own particular scientific character (C⁺⁺).

Framing

Table 3 shows the breakdown of the task units with mathematical content by kindergarten category. It indicates the teaching choices of preschool teachers in the cases of hierarchical rules, pacing, and evaluative rules.

By studying the data in Table 3, we conclude the following for each of the 'framing' cases:

I. *Hierarchical rules*: Variation between the two kindergarten categories is observed as far as the interaction of teachers-students is concerned during the teaching process ($p \leq 0.01$). In the category of working-class social context, pre-school teachers chose to

TABLE 3

**Framing of the task units with mathematical content
in the two kindergarten categories**

Framing		Middle-class social Context	Working-class social Context
		N (%)	N (%)
Hierarchical rules	F ⁺ (%)	71 (67.6)	67 (94.4)
	F ⁻ (%)	34 (32.4)	4 (5.6)
Pacing	F ⁺ (%)	68 (64.8)	53 (74.6)
	F ⁻ (%)	37 (35.2)	18 (25.4)
Evaluative rules	F ⁺ (%)	95 (90.5)	43 (60.6)
	F ⁻ (%)	10 (9.5)	28 (39.4)

teach mathematics almost exclusively with a teacher-centered method (67 task units, 94.4%). The next excerpt (Extract 3) is a typical example of this category.

The teacher talks about seasons. She wants children to group months by three in order to make the four seasons.

T: Now, look, we will put the months together, in groups of three and we will create the seasons. We have said that in the past, do you remember?

Students: No.

A student: I do not understand

T: You don't understand? I will explain it to you.

The teacher starts placing the cards with the months in order, creating groups of three.

T: These months presented here in order, are twelve. We will put them in groups of three. Three months together make a season.

Extract 3 F⁺ hierarchical rules, from kindergartens of working-class social context

In the case of middle-class context kindergartens, a predominantly teacher-centred teaching method was implemented (71 task units, 67.6%). A significant percentage of task units provided great autonomy to students to approach, develop, and conquer school mathematical knowledge (34 task units, 32.4%).

2. *Pacing*: The teachers of both categories of kindergartens chose a fast pace (F⁺ pacing) for teaching mathematics. This phenomenon is more pronounced in the case of kindergartens of working-class social context (working class social context: 53 task units, 74.6% - middle class social context: 68 task units, 64.8%). This option indicates that during most of the teaching activities, students did not have the necessary time to reach out and understand the mathematical knowledge offered in kindergartens.

3. *Evaluative rules*: Variation exists between the two cases of kindergartens in regard to the application of the evaluative rules during the teaching process ($p \leq 0.01$). Those rules refer to whether or not pre-school teachers provide clear guidance to students in order for those students to understand what is expected of them when approaching mathematical knowledge. More specifically, in kindergartens of middle-class social context, as shown in Extract 1, pre-school teachers almost always gave the necessary guidance to students on what actions they should take to answer questions or issues that arise during the teaching process (95 task units, 90.5%). In kindergartens of working-class social context, by comparison, a significant percentage of unclear evaluation criteria were given to students during teaching activities. In these cases, students' feedback on dealing with mathematical concepts was insufficient (28 task units, 39.4%).

Instructional strategies

Table 4 shows the breakdown by category of schools, of teaching strategies implemented by teachers in teaching mathematics. Data show a variation between the two categories of school contexts regarding the teaching strategies used by preschool teachers to teach mathematics ($p \leq 0.01$).

TABLE 4

Instructional strategies in teaching mathematics			
Instructional strategies		Middle-class social context	Working-class social context
		N (%)	N (%)
Localizing mathematical strategies	Nominal	26 (24.8)	31 (43.7)
	Ritual	25 (23.8)	19 (26.8)
	Mechanical	4 (3.8)	5 (7.0)
Specializing strategies	Proceduralizing	42 (40.0)	16 (22.5)
	Principling	8 (7.6)	0 (0.0)

More specifically, in kindergartens of working-class areas localizing mathematical strategies prevailed (55 task units, 77.5%), showing that pre-school teachers insisted on teaching mathematical concepts of a simple and specific nature, as in the case of Extract 4. The implementation of localizing mathematical strategies capitalizes on the experience of students, while possession of specialized mathematical knowledge is not required. The majority of localizing mathematical strategies in working-class context kindergartens belongs to the nominal and ritual cases. This shows that working-class kindergartens, the content of taught mathematical knowledge is "poor" and focuses mainly on naming geometric shapes or numbers (nominal: 31 task units, 43.7%) and, following teacher's guidance, on the repetition of words or sentences with mathematical content (ritual: 19 task units, 26.8%).

The pre-school teacher browses the calendar with the days and invites a student to recognize the dates.

T: What was the date of the month on Friday?

S: Five.

T: On Saturday;

S: Six.

T: So, Saturday was six. What was Sunday;

S: Seven.

Extract 4 Example of a localizing-nominal strategy, from working-class social context

In the case of middle-class context kindergartens we observed that in almost half of task units, specializing strategies for teaching mathematics were applied (47.6%). Most of were proceduralizing (42 task units, 40.0%), as they involved associations, naming geometric shapes and numbers and writing of mathematical symbols. The number of mathematical activities with applied specializing-principling strategies were few (8 task units, 7.6%). Their solution required possession and use of specific mathematical knowledge, as shown in the case of Extract 5. Note that specializing-principling strategies were not implemented in any of the working class context kindergartens.

The pre-school teacher poses a subtraction problem and invites children to use their fingers to determine the result.

T: You watch me now. If from this bowl (showing a container with ten markers) I remove four, how many markers will be left in the bowl?

Some students: We don't know.

T: Show me with your fingers how many markers are in the bowl? I said there are ten.

Some students: This many Ms (show fingers of both hands).

T: If we close four fingers, how many will remain?

Many children closed four fingers.

T: How many fingers remained?

S: (loudly counting their fingers) One, two ... six. Six Ms!

Extract 5 Example of a specializing strategy, from middle-class social context

Classroom organization

Data in table 5 exhibit variation between the two categories of schools regarding the choices made by pre-school teachers in teaching mathematics to their students based on classroom organization ($p \leq 0.01$). In the case of a working-class social context, most preschool teachers chose to work with all of their students (homogenous classroom organization: 59 task units, 83.1%). The homogenous classroom organization was also chosen frequently by teachers in middle-class context kindergartens (61 task units, 58.1%). In middle-class schools, however, task units taught using integrated classroom organization (31.4%) was significant, and students worked in groups to approach mathematical knowledge. This shows that in schools of middle-class areas, there was an attempt to apply a collaborative and interactive way of learning that is compliant with the guidelines of the new pre-school curriculum for teaching mathematics.

TABLE 5

Classroom organization in both school categories		
Classroom organization	Middle-class social Context N (%)	Working-class social Context N (%)
Homogenous (%)	61 (58.1)	59 (83.1)
Specialized (%)	11 (10.5)	8 (11.3)
Integrated (%)	33 (31.4)	4 (5.5)

DISCUSSION AND CONCLUSION

Table 6 presents the teaching model that prevailed in each of the two kindergarten categories according to the findings of the research presented above.

TABLE 6

Predominant teaching model by kindergarten category for teaching mathematics		
Pedagogical practices parameters	Middle-class social Context	Working-class social Context
Classification	C ⁺⁺	C ⁻ , C ⁺
Hierarchical rules	F ⁺ , F ⁻	F ⁺
Pacing	F ⁺	F ⁺
Evaluative rules	F ⁺	F ⁺ , F ⁻
Instructional Strategies	Specializing/Proceduralizing Localizing/Nominal Localizing/Ritual	Localizing/Nominal Localizing/Ritual
Classroom organization	Homogenous	Integrated

Data in table 6 indicate that a common element in both categories of school

environments is the strong framing pace (F^+). This means that pre-school teachers have tried to teach mathematical concepts using a fast pace but without devoting the necessary time needed by students to process and understand those concepts. In all the other cases, it appears that two different models are shaped depending on the social background of students.

In the case of a middle-class social context, where students whose parents had college degrees and worked in professional occupations, we observe that mathematics is taught as a separate module (C^{++}) with the implementation of mixed hierarchical rules (F^+ , F^-). This leaves some room for students to act alone and conquer mathematical knowledge. Furthermore, mathematical knowledge derives mostly from the esoteric domain and is provided by teachers applying specializing instructional strategies (47.6%), and also by discovering school education mostly through students' teamwork (integrated classroom organization, 31.4%). Throughout the teaching process, pre-school teachers gave clear instructions and directed their students to search and find the correct answer (F^+ evaluative rules, 90.5%). The observation of teaching in kindergartens of middle-class social context showed that these students had acquired all the necessary early conceptualizing experiences to a sufficient degree (Holland 1981). This enabled teachers to adjust their orientation to context-independent meanings (Bernstein, 1971; Hoadley, 2007) and introduce students gradually to the esoteric domain of school mathematics (Dowling 1998, 2002). Thus, pre-school teachers of these schools chose to deal with mathematics as a separate subject of the pre-school curriculum. In addition, according to Bernstein (1991) a strong framing pace, applied in the case of middle-class context kindergartens, seemed to be easier path for students coming from advantaged socioeconomic environments and who were familiar with school practices.

In the case of working-class context kindergartens, where the majority of parents worked as skilled or unskilled workers, efforts were made to provide mathematical knowledge through teaching activities with an interdisciplinary character (C^- , C^+). This assisted students in gaining better understanding mathematical concepts. In these schools, however, mathematics was taught in a teacher-centred manner (F^+ hierarchical rules), as teachers directly taught and addressed to all students in the class (homogenous classroom organization, 83.1%). The homogenous organization, applied here, shows that students were treated all in the same way; specific knowledge conception rates of students were not taken into account, nor were their cognitive characteristics. This way of teaching, however, is not conducive to children who have difficulties in understanding mathematical concepts (Dowling, 1998; De Abreu & Cline, 2003; Hoaldehy, 2007). Moreover, the mathematical knowledge selected to be taught to students of working-class areas derived mainly from the public domain (Dowling, 1998) and was offered with the application of localizing instructional strategies (77.5%). These strategies suggest that "poor" content of mathematical knowledge was offered

to students, with it limited to practices of naming numbers and geometric shapes, and imitating teacher actions. This was a rather superficial approach, not providing a deep understanding of school mathematical knowledge. Furthermore, the observation of teaching in kindergartens located in working-class areas highlighted the difficulty that many students had in understanding the mathematical concepts being taught. This often led pre-school teachers to deliver incomplete efforts of knowledge presentation and evaluation (F^+ evaluative rules) and fast transitions (F^+ pacing) to their instructional choices.

Although the results of this research cannot be generalized, they still provide a clear indication that pre-school teachers in the sample understand mathematics. Mathematics is one of the main school subjects of the Greek curricula (Koustourakis & Zacharos, 2011), a subject with clear scientific boundaries in the pre-school curriculum (C^{++} , C^+). The development of school mathematical knowledge and its teaching in the schools, however, deviated from the goals of the modern pre-school curriculum (Ministry of National Education 2003). In fact, in many cases of teaching mathematics, a traditional teaching model comes to the fore. To a great extent, teachers in the sample try to teach mathematics in a traditional sense, which is related to the implementation choices of homogenous classroom organization, strong pacing and strong hierarchical rules of framing. This is a clear variation from the constructivistic choices, promoted by the new preprimary curriculum for teaching mathematics. The preceding remarks apply, to a greater extent, in schools located in working-class areas, where teaching practices draw the content of school knowledge from the public mathematical domain and, finally, focus primarily on the presentation of context-dependent mathematical meanings (Bernstein, 1971; Dowling, 1998).

On the other hand, teachers working in schools of middle-class social context chose largely to teach mathematics as an autonomous curriculum subject, and gave greater weight to the presentation and processing of context-independent mathematical meanings. Additionally, such teachers have tried to give students initiatives and enhance their autonomy to acquire knowledge.

Therefore, from the analysis and processing of the research material we observe students' social backgrounds significantly impact and lead to variations in pre-school teachers' pedagogical practices in their efforts to teach mathematics in Greek kindergarten. Another finding is that pre-school teachers have a difficult time in implementing the new pre-school curriculum. To face this problem, appropriate training of pre-school teachers could help, including theoretical and practical training in the constructivist character teaching methods proposed by the contemporary pre-school curriculum for teaching mathematics.

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