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Relationship of Pupils' Spatial Perception and Ability with Their Performance in Geography

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Abstract

The aim of this study was to investigate the correlation between pupils' spatial perception and abilities and their performance in geography. The sample was 600 6th-grade pupils from various areas of Greece selected by the cluster sampling method. The study results showed that: a) the vast majority of pupils showed low spatial ability; b) there was a deficit of geographical knowledge (according to the curriculum), with satisfactory performance only in plan views and orientation; c) the pupils who showed higher performance in geography course assessment test and in geographical abilities test have better spatial perception; d) the school type (pilot school using new technologies, and traditional school) did not seem to cause any difference to the pupils spatial perception; e) Pupils' gender was not found to cause significant difference to spatial perception, or to their performance; f) parents' education was found to correlate with the pupils' performance in geography.

Keywords

Spatial Ability; Spatial Perception; Primary Education; Pupils Performance; Geography; Greece

Spatial ability is one of the most important skills that humans have developed in their effort to better adjust to the environment in which they live and evolve (Bishop, 1980).

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Gersmehl and Gersmehl (2007) defined spatial perception as a set of skills that geographers use to analyse the spatial relationships in the surroundings. They identified thirteen modes of spatial thinking: defining a location, describing conditions, tracing spatial connections, spatial comparisons, drawing conclusions from spatial influences, delimiting a region, identifying spatial analogies, discerning spatial patterns, assessing spatial associations, designing and using spatial models, etc.. They argued that neuroscience research suggests that these modes of spatial thinking have distinct or independent neurological functions.

Today spatial perception is deemed as a primary skill, which actually plays a significant role both in the scientific mode of thinking, and in other sectors of human activity, such as humans' ability to handle language and, in the long run, thinking in an effective manner (Bishop, 1980, Li & Gleitman, 2002). It is also entangled in a series of complex procedures, such as learning, training, homework and even game (Rafi, et al., 2005). Many scholars have actually defined spatial ability as a focal point in a series of sciences and scientific activities, such as mathematics (Gallagher, 2001; Wolfgang, Stannard & Jones, 2003; Battista, 2007), science studies (Wu & Shah, 2004; Uttal, Miller & Newcombe, 2013; Kozhevnikov, 2007), music (Zafranas, 2004), creativity (Lohman, 1993; Liben & Titus, 2012).

Teachers, psychologists, and scientists in general are preoccupied with improving spatial skills and finding suitable training methods for cultivation and development thereof (Pellegrino, et al., 1983; Uttal, Miller & Newcombe, 2013). Despite the debates, it is widely agreed that without developed spatial ability, students often face difficulties in learning various cognitive objects, and finally in the field they choose to study (Bertoline, 1998; Liben, 2006). Moreover, researchers agree that spatial skills can be acquired through proper education and training (Lee & Bednarz, 2009; Newcombe, 2010; Kastens & Ishikawa, 2006; Sarno, 2012; Ishikawa, 2016), with activities correlating with studying and designing maps and with using geography road map materials.The latter can replace the stereotypical view of geography as fact-based and descriptive with a balanced and integrated view of geography that recognizes the importance of learning place names, locations, and terminology, which have historically characterized geography education (Rutherford, 2015; Schell, Roth, & Mohan, 2013). In this context, it has also been proposed that geography be systematically taught from preschool age and throughout primary and secondary education, as it cultivates spatial perspective in learning, while students are equipped with skills of problem-solving and decision-making with scientific and humanistic completeness (Lambrinos, 1998; Marran, 2003; Gryl, Jekel & Donert, 2010; Gryl & Jekel, 2012). Additionally, it is worth to point out that according to Bednarz & Bednarz (1995) for improving the geography teaching ability of inservice teachers has to be matched by efforts to improve opportunities for preservice teachers to learn geography and how to teach it.

Furthermore, knowledge around geospatial technologies and learning remains sparse, inconsistent and overly anecdotal. (Baker, Battersby, Bednarz et.al, 2015). The researchers claim that this issue requires studies that are better structured, more systematic and replicable, attentive to progress, and findings in the cognate fields of science, technology, engineering and math education (STEM) (Baker, Battersby, Bednarz et.al, 2015).

On the other hand, Sarno (2008) argues that the development of spatial ability is crucial for geography, as it is a necessary element of methodology for training in this sector. The results of Sarno's study (2008) show that two significant factors of spatial ability, orientation and representation may be developed with the use of suitable teaching strategies. Didactic activity develops the capacity for exploration, localisation and analysis of spatial elements. With a suitable curriculum, all the children can take part in experiences-activities that will help them develop their spatial skills.

According to a study of Bloom & Palmer-Moloney (2004), spatial perception is the specific cognitive code for geography, and without it learning is mnemonic, it loses its usefulness in every-day life and ceases to be an integral part of the process of thinking. Therefore, development of spatial abilities aids the study of geography and contributes to overcoming apathy and indifference with regard to the environment.

Moreover, through global research and the philosophy of new curricula in Greece, where there is explicit reference to the necessity of developing students' spatial perception and skills in compulsory education, we would like to examine the relationship of pupils' performance in geography with spatial abilities and perception.

More specific, in Greece, school geography in primary education until 2011 followed mostly the traditional way of teaching, using mainly wall paper maps and textbooks as the only educational material, even if in 2003 a Crossthematic Curriculum Framework Syllabus (http://ebooks.edu.gr/info/cps/23aps_GelogiasGeografias.pdf) was designed for compulsory education (from kindergarden to 9th grade) and was implemented in all Greek schools. This curriculum text was treated as a policy text which introduced important changes in Greek school practice, adopting cross-curricular approaches. Since 2011 another educational reform was designed for compulsory education (New School "School of the 21st Century"), which was constructed by the Hellenic Pedagogical Institute and was applied in specific Greek schools (45 primary pilot schools). These curricula introduced important changes in Greek school practice, mainly through the adoption of the new technology in teaching and learning, e-books and the creation of digital educational material for all subjects. The core argument of the policy actors involved in this reform is that this particular innovation is a good curricular practice that will contribute to the further modernization of compulsory schooling in Greece. It is also claimed that this intervention is based on the Greek educational context as well as European educational policy. More specific, in New Geography Curriculum (NGC) (http://ebooks.edu.gr/info/newps/Φυσικές%20επιστημες/Γεωγραφία%20Δημοτικού.pdf) were adopted innovative teaching methods, new digital educational materials implemented in students' activities, such as the use of 2D and 3D maps, GIS (Geographic Information System), virtual environments, simulations, aerial and satellite images e.t.c. Furthermore, for the first time (2011), the NGC introduces spatial concepts and sets the development of students'spatial abilities as one of the major goal. The NGC was initially introduced in a pilot way in 45 schools in Greece selected by the Ministry of Education and Religious Affairs with cluster sampling method (the number of schools -depending on the total number of pupils- in each educational district was randomly selected).

The purpose of this research is to investigate i) whether there is a relationship between spatial perception and pupils' performance in the geography course and ii) if implementing NGC in teaching and learning managed to improve pupils' spatial abilities and their performance in geography.

Methodology

The Sample

The study was carried out 2014-2015. Data collection lasted 6 months (September 2014 – February 2015). The sample consists of 600 6th grade pupils from almost all the Greek regions except from Thraki, Ipiros and Ionia islands where the schools did not respond. According to the Greek Statistical Authority (2014-2015) the general primary pupil population in Greece was 629.373. At the 6th grade there were 100.563 pupils. According to Karagiorgos (2002) we will not expect a sampling error greater than 5% refering to the population of 100.000 by using the sample of 500 individuals. Therefore the sample is representative. The researchers collected the sample by visiting most of the schools (2/3 of the total sample). To schools located very far away from Athens the questionaires were sent by mail, but unfortunately only few of these schools respsponded to (1/3 of the total sample). Researchers chose equal number of schools, in the same educational district, either from those that implemented the New Geography Curriculum -assuming that teachers follow the Pedagogical Institute guidelines, implementing innovative teaching methods, using new technologies, e-books, digital material from Photodentro (http://photodentro.edu.gr/aggregator/), etc- or from those that followed the traditional way of teaching. The basic demographic characteristics of the sample are presented in Table 1, 2. In total, the 600 pupils were 11-13 years old (Mean Value=11.75 Standard Deviation=0.46), and came from 22 different schools, divided into 33 different classes. Out of these classes, 18 (54.6%) belonged to pilot schools, which were required to implement the New Geography Curriculum, while 15 (45.4%) (there were 3 schools that have less 6th grade classes than the pilot ones) followed the older Crossthematic Geography Curriculum and the old geography textbooks. The number of students in schools that followed the old Crossthematic Geography Curriculum was 264 and students that followed the New curriculum (pilot) were 336 (see Table 1). Moreover, out of the total of the participants, 301 were boys (50.2%) and 299 (49.8%) were girls (Table 2). As regards their parents' education, most of the pupils mentioned that their parents had completed secondary education. Tables 3, 4 contain detailed descriptions of frequencies for each educational degree for mothers and fathers respectively. It is also noteworthy that about one third of mothers (36.7%) and fathers (35%) were holders of a university degree.

Table 1
Pupils (the sample)

	Frequency	*%*	**Total %**
New curriculum (pilot)	336	56	56
Old crossthematic curriculum	264	44	44
Total	600	100	100

Table 2
Pupils' Gender

	Frequency	*%*	**Total %**
Boys	301	50.2	50.2
Girls	299	49.8	49.8
Total	600	100	100

Table 3
Absolute and relevant frequencies of mothers' education

	Frequency	*%*	**Total %**
Primary Education	76	12.7	12.7
Lower Secondary Education	52	8.7	21.4
Upper Secondary Education	252	42	63.4
University	220	36.7	100
Total	600	100	

Table 4
Absolute and relevant frequencies of fathers' education

	Frequency	*%*	**Total %**
Primary Education	67	11.2	11.5
Lower Secondary Education	57	9.5	21.0
Upper Secondary Education	266	44.3	65.3
University	210	35.0	100
Total	600	100	

Research tools

The research team selected the quantitative research approach and used the survey as its metholological instrument of choice. The survey instruments used in this study was: a) A test of spatial perception of J. Tsaousis. The test consists of three sections: the first section examines the person's ability to mentally rotate various shapes, the second section refers to the ability to discern different 3-dimensional shapes from different visual angles (plan views), the third section relates to the individual' s ability to perceive the process complex 3-dimensional patterns (refolding items); b) the scale of measurement MI (Multiple Intelligences) of Armstrong, which includes 10 self-report statements for each type of intelligence (linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, naturalist); c)) an assessment test with geography activities relating to the pupils' spatial abilities, in accordance with the model of Gersmehl & Gersmehl (2007), for the purpose of measuring the pupils' performance in the specific course, in combination with the grade they had in the term, and the score they received in the last geography assessment test they had taken in the classroom. The test consists of 10 questions in order to evaluate the following spatial abilities: spatial concepts, spatial analogies, spatial hierarchies, spatial associations, spatial groups (regions), spatial patterns, spatial sequences and transitions, spatial comparisons, plan views and orientation.

Results and Discussion

Initially, pupils' geospatial abilities on spatial concepts, spatial analogies, spatial hierarchies, spatial associations, spatial groups (regions), spatial patterns, spatial sequences and transitions, spatial comparisons, plan views and orientation was investigated (Table 5). At the geography test with the spatial perception activities, the sample pupils received on average 5.08 points (S.D.=1.82) for all the questions. Table 5 presents the indices of central tendency and dispersion of the total score of the pupils in the 10 questions of the geography test.

Table 5
Indices of central tendency and dispersion of the pupils' answers at the geography test

	Mean	*S.D.*	*Mode*	*Median*	*min*	*max*
Geography Test (spatial skills) total score	5.08	1.82	6.00	5.00	1	9.30

Firstly, from pupils' answers to the above set of questions, it is clear that 285 pupils (47.5%) failed (<5), while 206 of them (34.3%) barely passed, scoring "Good" (5 & 6). Ninety pupils (15%) achieved a very good score (7 & 8). Finally, 19 pupils (3.2%)

achieved a score over 9 ("Excellent"). Practically, 4/5 of them (81.8%) scored from "1" to "6.9" (below "7").

Table 6 presents the frequencies of quality scores (wrong-partly correct-correct-no reply) of the pupils' answers per question. Then, following a short overview, it seems that the pupils had more difficulty with question 8 (spatial comparisons), as only 64 (10.7%) of them answered it correctly. Question 2 (spatial analogies) can also be considered highly difficult, as there were 273 wrong answers (45.5%), while 147 pupils did not answer at all (24.5%). Similarly, on question 7 (spatial sequences) there were 207 wrong answers (34.5%), while 171 pupils did not answer at all (28.5%). On question 4 (spatial effects) most of the pupils answered correctly, but only partly (74.8%). The same was the case with answers to question 5 (spatial groups): Three hundred and eight pupils (51.3%) gave a partly correct answer, while 145 (24.5%) gave a correct one. By contrast, on question 9 (plan views), almost all the pupils gave the correct answer. To be specific, only four pupils failed to answer (0.6%), while 13 pupils gave a partly correct answer (2.2%).

The last column of the table shows the mean scores of the pupils' answers (where 0= "wrong answer" and "no reply", 0.5= "partly correct", 1= "correct") to each question separately. It should be noted that on questions 9a and 9b the correct answer scores "0.5" for the calculation of the total score at the test, and "1" for the calculation of the individual average score. Based on these scores, they can easily be classified by order of difficulty, beginning from the most difficult to the easiest one, as follows: 8 - 2 - 7 - 4 - 1 - 5 - 6 - 3 - 10 - 9b - 9a.

Table 6

Distribution of Frequencies of the Results of the Pupils' Answers to the 10 Questions of the Geography Test

	Wrong *f (%)*	**Partly correct** *f (%)*	**Correct** *f (%)*	**No reply** *f (%)*	***Mean (S.D.)***
Spatial concepts	236 (39.3)	2 (0.3)	260 (43.3)	102 (17)	0.44 (0.50)
Spatial analogies	273 (45.5)	2 (0.3)	178 (29.7)	147 (24.5)	0.30 (0.46)
Spatial hierarchies	21 (3.5)	301 (50.2)	209 (34.8)	69 (11.5)	0.63 (0.35)
Spatial effects	49 (8.2)	449 (74.8)	44 (7.3)	58 (9.7)	0.41 (0.26)
Spatial groups(regions)	147 (24.5)	308 (51.3)	145 (24.2)	-	0.50 (0.35)

Spatial patterns	262 (43.7)	-	336 (56)	2 (0.3)	0.56 (0.50)
Spatial sequences	207 (34,5)	12 (2)	210 (35)	171 (28.5)	0.36 (0.47)
Spatial comparisons	186 (31)	178 (29.7)	64 (10.7)	172 (28.7)	0,25 (0.34)
Plan views(a)	4 (0.7)	13 (2.2)	583 (97.1)	-	0,98 (0.11)
Plan views (b)	145 (24.2)	1 (0.2)	453 (75.4)	1 (0.2)	0,76 (0.43)
Orientation	14 (2.3)	317 (52.8)	269 (44.8)	-	0,76 (0.27)

Secondly, at the spatial perception test, the highest score is found at the dimension "Plan views", i.e. at the person's ability to discern three-dimensional shapes from a different visual angle. An intermediate score is noticed at "Mental rotations", i.e. a person's ability to mentally rotate shapes, while the lowest one is found at the dimension "Refolding items", which involves the person's ability to perceive and mentally process complex, three-dimensional designs (Table 7).

Table 7
Indices of Central Tendency and Dispersion of the Participants' Answers at the Spatial Perception Test

Intelligence Types	***Mean (D.I.)***	***S.D.***	***Mode***	***Median***	***Distortion index (D.I.)***	***Buckling index (B.I.)***	***Kolmogorov-Smirnov Z*** **(*B.E.*=595)**
Mental Rotations	4.76 (0.10)	2.53	6	4	0.35 (0.10)	-0.53 (0.20)	0.127**
Plan Views	5.16 (0.10)	2.42	5	5	0.64 (0.10)	0.02 (0.20)	0.142**
Refolding Items	3.43 (0.07)	1.66	4	4	0.38 (0.10)	-0.02 (0.20)	0.145**
Total	13.35 (0.20)	4.79	11	13	0.55 (0.10)	0.32 (0.20)	0.10**

**$p<0.01$

The pupils' performance in dimensions and the total spatial perception, as well as their assessments of their spatial intelligence level were correlated with their performance score at the latest Geography test and with their score at the Geography assessment test that was constructed for the purposes of this study. Table 8 presents associations with the criterion *Spearman ρ.* In total, there are associations with all the dimensions and the total spatial perception, but also with spatial intelligence. Pupils performing better at the test and at the Geography assessment also have better spatial perception. Also, pupils stating higher spatial intelligence also perform better at the test and at the Geography assessment.

Furthermore, it was also examined whether there is any difference in spatial perception between pupils of pilot schools and pupils of traditional schools. Following testing with the *Mann-Whitney* criterion, no statistically significant difference was traced as regards the three dimensions [*Mann-Whitney* $z_{Mental\ Rotations}$=-1.90, *p*=.06, *Mann-Whitney* $z_{Plan\ Views}$=-.97, *p*=.33, *Mann-Whitney* $z_{Refolding}$=,66, *p*.,51] and total spatial perception [*Mann-Whitney z*=-1.70, *p*=.09] for pilot school pupils compared with traditional school pupils. The school type does not cause any difference to the pupils' spatial perception.

Table 8

Associations (Spearman P) Between Pupils' Answers on Spatial Perception, Spatial Intelligence and Their Performance at Geography

	1 Ment. Rot.	2 Plan View.	3 Refol. Item	4 Spat. Perc.	5 Stud. Sp. Int.	6 Geo. Test
1. Mental Rotations	1					
2. Plan Views	.30*	1				
3. Refolding Items	.13**	.26**	1			
4. Spatial Perception (total)	.74**	.75**	.75**	1		
5. Students' Spatial Intelligence	.17**	.22**	.07	.22**	1	
6. Geography Test	.23**	.24**	.14**	.29**	.43**	1
7. Examination score	.17**	.11**	.12**	.20**	.28**	.43**

**p<0.01.

Finally, comparisons of pupils' performance from traditional and pilot schools regarding their scores on the Geography test, Spatial Intelligence test (Multiple intelligences) and Spatial Perception test are presented in Table 9.

Table 9

Comparisons of Students' Performance from Traditional and Pilot Schools Regarding Their Scores on the Geography Test, Spatial Intelligence (Multiple Intelligences) and Spatial Perception

	Traditional (N=264)	**Pilot (N=336)**	***Mann-Whitney U***	***Z***	***p***
Geography test	301.52	299.70	44,620	.127	.90

Test of MI	309.65	292.39	46,768	1.229	.22
Test of spatial perception	285.44	309.60	40.333	-1.700	.09

The relationship of gender with pupils' spatial perception and performance was also examined. Gender was not found to cause any significant difference to the degrees of spatial perception of the participants. The difference was tested with the *Mann-Whitney* criterion, and it was found that it is statistically insignificant, reaching even 5% of statistical significance both for individual spatial perception dimensions [*Mann-Whitney* $z_{Mental\ Rotations}$=-.40 *p*=.69, *Mann-Whitney* $z_{Plan\ Views}$=-.35 *p*=.72, *Mann-Whitney* $z_{Refolding}$=-1.00 *p*=.32] and for the total spatial perception [*Mann-Whitney z*=-1.08 *p*=.28]. Male and female pupils showed similar total spatial perception. The boys and girls of the sample can discern three-dimensional shapes from a different visual angle, can perceive and mentally process complex three-dimensional designs, and can mentally rotate shapes equally, in about the same manner. Moreover, there were no significant variations in mean performance scores (Geography test, score for the term) in terms of gender. The difference was tested with the *Mann-Whitney* criterion, and it was found that it is statistically insignificant, reaching even 5% of statistical significance both for individual spatial perception dimensions [*Mann-Whitney* z_{test}=-.1,86 *p*=.06, *Mann-Whitney* z_{Test}=-.1,18 *p*=.24, *Mann-Whitney* z_{term}=-75 *p*=.45].

Finally, the possible correlation of the parents' educational level with the children's performance at the subject of geography was explored. The pupils' scores seem to correlate significantly with the **mother's educational level**. As regards the *Geography* test, pupils whose mothers had higher education scored better compared to the pupils whose mothers had lower education (Table 10).

As regards the **father's educational level**, it seems to correlate significantly with the students' scores. As regards the *Geography* test, we found that pupils with highly educated fathers scored better than pupils whose fathers had lower education (Table 10).

Table 10

Check by the Kruskal-Wallis Criterion of the Comparison of the Regular Values of the Pupils' Performance as To Their Parents' Educational Level

	Mother's educational level				
School performance	**Primary Education (*N*=76)**	**Lower Secondary Education (*N*=52)**	**Upper Secondary education (*N*=252)**	**Universities (*N*=220)**	***Kruskal-Wallis H* (*B.E.*3)**
Geography	304.48	223.41_a	273.53_b	$348.24_{a,b}$	33.12^{**}

Test					
Score for the term	$237.93_{a,b}$	$195.54_{c,d}$	$293.20_{a,c,e}$	$355.29_{b,d,e}$	60.49^{**}
Examination score	295.24_{a}	$193.76_{a,b,c}$	$289.39_{b,d}$	$340.28_{c,d}$	33.66^{**}

School performance	**Father's educational level**				***Kruskal-Wallis H* (*B.E.*3)**
	Primary Education (*N*=67)	**Lower Secondary Education (*N*=57)**	**Upper Secondary education (*N*=266)**	**Universities/ (*N*=210)**	
Geography Test	318.59_{a}	$219.32_{a,b}$	269.20_{c}	$356.40_{b,c}$	43.76^{***}
Score for the term	236.63_{a}	249.88_{b}	279.68_{c}	$360.99_{a,b.c}$	51.03^{***}
Examination score	297.13	221.48_{a}	276.03_{b}	$354.01_{a,b}$	38.62^{***}

*****p<.001. Note:** The average scores with the same indices show differences in pairs ($p<0.05$).

Conclusions

This research showed that there is a deficit in geographical knowledge. The same deficit was also observed in older studies (Lambrinos, 1998; Katsikis, 2001; Klonari 2002; Klonari & Karanikas, 2004; Klonari & Koutsopoulos, 2005), which is indicative of the same static state of geography, since it is still considered to be a subject of minor importance.

It was also found that at the geography test, orientation and plan views were quite easy for the children. By contrast, they had great difficulty with spatial sequences, analogies, and comparisons. Also, at the spatial perception test, the highest score was achieved at the "plan views perception", an intermediate score was achieved at "mental rotations", and the lowest score was achieved at "refolding items". The foregoing observations are due to the fact that teachers use only static mapping, as opposed to mapping through digital technology (three-dimensional maps, satellite images, GIS use, Photodentro, etc.), which help students better understand the space and develop their spatial abilities. (Allen 2007; Doering & Valetsianos, 2007; Lee & Bednarz, 2009; Apostolopoulou & Klonari, 2011). Although in pilot schools, where teachers have been retrained and apply the new curricula with the use of new technologies and digital school (2D and 3D maps, aerial photographs and rich educational material posted on the Photodentro), one would expect a significant improvement of the level of geographical knowledge (Injeong and Bednarz, 2014) yet almost the same deficit as before is observed. This is possibly due to the fact that teachers do not properly implement the new curricula (Klonari, 2011) in a more active manner, based on rounded experiential involvement of pupils, but they opt for a more traditional - teacher-centered manner of teaching, where pupils have a passive role (Sanli, Sezer & Pinar, 2016).

Moreover, it is noteworthy that pupils who achieved higher scores at the test and at the Geography assessment also had better spatial abilities, but also that pupils who reported higher spatial perception, also had a higher performance at the test and at the Geography assessment. This proves the close correlation of geography with spatial perception and abilities and the need for development thereof through the specific subject. We only present pupils' results, but teachers' training, teaching methods and other factors play an important role in pupils learning outcomes (Bednarz & Bednarz, 1995).This study is part of a wider research that includes teachers and their role in the development of pupils' spatial perception and abilities. However, the results of this research will be published in a future paper.

It is also worth to be noted that while the use of teaching tools, such as aerial photographs, satellite images, is recommended so that students will improve the level of their geographical knowledge (Condie et al., 2007), the school type (pilot with the use of new technologies, and more traditional school) did not seem to cause any difference to the pupils' spatial perception and abilities. This finding may be due either to the fact that teachers avoid teaching the subject through the use of new technologies, because it requires a lot of preparation time, and they opt for the easy solution of the book, or to the fact that their notion of geography (they consider it to be of minor importance, and they rank it at the last but one position in relation to the other subjects) (Klonari & Likouri, 2015) does not allow them to improve their teaching.

Moreover, it was found that gender affects neither spatial perception nor pupils' performance in geography. This finding corroborates the findings of older studies on the relationship between gender and spatial perception (Hyde, Geiringer, & Yen, 1975; Gear, Saults, Liu & Hoard, 2000; Jones, Braithwaite & Healy, 2003). Of course many scholars (Rilea, Roskos-Ewoldsen & Boles, 2004; Levine, Vasilyeva, Lourenco, Newcombe & Huttenlocher, 2005; Silverman, Choi & Peters, 2007; Kubiatko, Mrazkova, Janko, 2012) disagree with the above finding, and maintain that men surpass women in spatial perception.

Finally, it was found, like in older studies (Kiritsis, 2008; 2011; Riala, Isohanni, I., Jokelainen, Jones, & Isohanni, M. 2003; West & Pennell, 2003) that the parents' educational level affects the students' school performance. Contemporary research data recognise the significance of the parents' socio-economic level for the child's academic career. Sakkas (2002), who studied family factors that correlate with learning difficulties in primary education, concluded that parents' education and their financial status affects children's performance. More parents with low education had children with learning difficulties, and at the lower financial level there were more students with difficulties than at the higher one, where there were mainly students with excellent performance. This is naturally due to the fact that parents, with their values, attitudes, notions, and their behavior and the daily practices they follow, affect the manner in which children perceive their abilities and approach success at school (Flouris, 1989).

Lastly, regarding future research, it is suggested that pupils' spatial perception and spatial abilities should be correlated with other subjects such as language, science, mathematics, history, art, gymnastics, and that it sould be furthermore investigated how the performance of pupils is consequently affected in this way.

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