PRELIMINARY RESULTS FROM A STATISTICAL INTEREST RESEARCH ON GEOSCIENCES CONTENT AND TEACHING STRATEGIES IN SECONDARY SCHOOLS IN GREECE AND SPAIN

Resultados preliminares de un análisis estadístico sobre preferencias en los contenidos y estrategias docentes de geología en la escuela secundaria en Grecia y España

Georgia Fermeli1, Guillermo Meléndez2, Michael Dermitzakis1, Amelia Calonge3, Friedrich Steininger4, George Makridis5

(1) Dpt. of Hist. Geology and Palaeontology, Faculty of Geology and Geoenvironment, National and Kapodistrian University of Athens, Panepistimiopolis, 15784 Zographou, Athens, Greece, (gfermeli@geol.uoa.gr, mdermi@geol.uoa.gr)

(2) Dpt. of Earth Sciences (Palaeontology), University of Zaragossa, Spain, (gmelende@unizar.es)

(3) Dpt. of Geology, Faculty of Sciences, University of Alcala de Henares, Madrid, Spain, (a.calonge@uah.es)

(4) Krahuletz Museum, Eggenburg, Austria, (Fritz.Steininger@senckenberg.de)

(5) 3rd Lyceum of Keratsini, Attiki, Greece (gsmakridis@yahoo.gr)

Abstract: The preliminary results of a topic-interest research on geosciences among 14 to 17 year-old school students are reported. The research is organized in the frame of the European project GEOschools to investigate the interest of students in the context and teaching strategies of geosciences in secondary schools.

A questionnaire was designed as the main data-collection instrument and based on the results of a comparison on geosciences curricula among five European countries (Austria, Greece, Portugal, Italy and Spain), which are the partners of GEOschools project.

The questionnaires were distributed in 20 schools (20 teachers and around 600 students) in each participating country. Preliminary results from this research concerning Greece and Spain are presenting in this paper. Specifically, a sample of 554, 14 and 15 year-old children was surveyed in 20 school across Greece and a sample of 155, 15 and 17 year-old children was surveyed in 7 schools in Aragon - Spain in order to identify existing geosciences interest.

Results indicate that the most attractive topics for children are Natural hazards and Palaeontology. Teaching strategies also raise high interest as a topic they feel concerned with. Children from Spain have less interest in geosciences generally than do children of the same age from Greece.

Resumen: Se presentan los resultados preliminares de un estudio sobre preferencias temáticas de Ciencias de la Tierra entre estudiantes de Secundaria (14 a 17 años). El trabajo se ha llevado a cabo en el marco del proyecto GeoSchools un proyecto de los programas de educación permanente (Longlife learning Programs) de la Unión Europea. El objetivo es analizar el interés preferente de los estudiantes por las distintas materias geológicas y las estrategias docentes en la escuela secundaria.

Con este objetivo se diseñó un cuestionario que a lo largo de 14 apartados diferentes cubría las distintas disciplinas geológicas, basado en los resultados de un análisis comparativo de los programas de ciencias de la Tierra y disciplinas próximas entre los cinco países que integran el proyecto (Austria, Grecia, Italia, Portugal y España).

Los cuestionarios se distribuyeron y completaron en un total de 20 centros escolares (aproximadamente un total de 20 profesores y 600 estudiantes en cada país). Los resultados preliminares de este primer sondeo, entre Grecia y España, proceden de una muestra de 554 encuestas entre estudiantes de 14 a 15 años en 20 escuelas secundarias en Grecia y de 155 encuestas realizadas sobre alumnos de 15 a 17 años en 7 centros de Aragón en España, entre Zaragoza, Huesca y Andorra (Teruel).

Los primeros resultados muestran que los temas que presentan un mayor atractivo para los alumnos son los Riesgos Naturales y la Paleontología. Las Estrategias docentes o la incorporación de nuevos modos de enseñanza también despiertan alto interés entre el alumnado, al ser un tema al que se sienten más vinculados. Asimismo, se constata que de un modo general, los estudiantes españoles muestran un menor interés por las ciencias de la Tierra que los estudiantes de Grecia a edades similares.

Keywords: Geoschools, interest research, geodidactics, geology, secondary school students

Palabras clave:

INTRODUCTION

It is known that not much detailed research has been undertaken on geosciences topic interest among school students. However geosciences contents are included typically within related research dealing with children interest in science in general. One of the main aims of the European project GEOschools is to investigate the interest secondary school students have on geosciences content and teaching strategies (Fermeli et al, 2011a; Fermeli et al, 2011b). A sample of 3.000, 14 to 16-year old children was surveyed in one hundred schools across 5 European countries in order to identify existing geosciences interest.

The research literature on children's interest in science is generally wide. However little research has been done so far on children's interests in geosciences. Trend (2007) organized a research across UK in order to investigate those topics on Geosciences that might hold widespread interest for high school students and also to identify any effects of gender and secondary school type on geosciences topic interest. The research concluded that "big events" is the most popular geoscience topic and "past time" the most popular geosciences theme. However, factor analysis of these results reveals the existence of a coherent "extreme events" factor i.e. a clear preference of boys, unlike girls, for catastrophic events. Therefore this high popularity is coherent but significantly gender-biased towards boys.

RESEARCH PROGRAMME AND METHODS

The present Interest Research study has focused on the analysis of the preferences of children from Greece and Spain aged 14 to 17 years, towards some selected

topics of geosciences. The data were obtained in 2012 on a sample of 707 children from 27 schools, in Greece (20 schools, 14-15 year old students) and the region of Aragón, Spain (7 schools, 14-17 year old students).

The research seeks to find possible substantial differences between particular subgroups of students that can be separated according to relevant educational or sociological variables such as gender, cultural background, geographic region, or socio¬economic status of the families.

The range of geosciences content was selected to reflect the breadth of geosciences curricula across GEOschools participating counties (Austria, Greece, Italy, Portugal and Spain). In order to enhance the researchers' context knowledge of curricula existing contents, a curriculum comparison research was made between the five participating countries (Calonge, 2011, 2012; Fermeli, 2011; Rodrigues & Catana, 2011). This previous study allowed identify a large number of geosciences items, which were provisionally incorporated into the research. Detailed curricula content was identified and then grouped in 14 main geosciences topics, covering the main elements of geosciences as represented in the school curricula, in the partner countries of GEOschools project.

A questionnaire was produced as the main data-collection instrument (Cohen & Manion, 1998; Oppenheim, 1992; Paraskevopoulos, 1990), the spread of questions covering 14 geosciences topics plus the teaching strategies, as shown in Table 1.

Using a 5-point score as a scale, the children were asked to respond to each question according to their level of interest in learning or finding out more about it: each item generated a score from 1 (minimum interest) to 5 (maximum interest). Only some preliminary results of the research concerning Greece and Spain are presented here, as a first approach to the results of the study.

The sample for this research was 3rd Class students of 20 High Schools all over Greece and 7 High Schools from the region (Autonomous Community) of Aragón-Spain, during the present academic year 2011-12. Schools were both state and private from different geographical regions (cities, suburbs, rural and isolated areas) in order to have as much as possible representative sample and students were chosen from 3rd class of high school because they

have already been taught geosciences for their obligatory education.

The students from Greece were in total 554 (41,9% boys, 53,2 % girls and 4,9% didn't answer) and the students from Aragon-Spain were in total 155 (40% boys, 59,3 % girls and 0,6% didn't answer.

THE QUESTIONNAIRE

Trial application

The trial application of the questionnaire was carried out in November 2011, on 30 students of 3rd Class of a High school in Athens-Greece.

The trial application was crucial for making a better formulation of questions (vocabulary, syntactic structure), and to suppress some particularly complex questions or to establish the required time for the completion of the questionnaire.

Questionnaire description

The questionnaire was designed by the GEOschools partners. After taking into consideration the results of the comparison research of the geosciences curricula from the GEOschools partner countries (Calonge, 2011, 2012).

The questionnaire contains a whole of 190 questions. Of all these questions, 11 concerned social information of the participants; seven of them were "open questions" and the remaining four were "closed questions" i.e. concerning the students' academic and family background. These questions should help identify substantial differences between particular subgroups of students that can be separated according to relevant educational or sociological variables such as gender, cultural background, geographic region and socio¬economic status of the families.

The remaining 179 questions concerned the main subject of the research. From these questions 2 were "open type short answer", 7 were "semi-open type short answer", and 170 were "closed type answers", which are answered in a five point Likert scale.

The "open questions" were used in the cases in which we wanted the participants' opinion about their local geological environment. The answers required were short

(a paragraph or a few words) and for this reason the space provided for the answer in the questionnaire was restricted. At the end of the questionnaire there was also place for a free comment. More complex or so-called "social type" questions were generally avoided (Paraskevopoulos, 1993). All remaining questions on the questionnaire were "closed".

The reason for this type of questions to be selected was the agreement in the type of answers, the easy coding and the reduction of time of completion and marking the questionnaire. The coding of the questions and their statistical treatment has been done by SPSS program. The questions concerned the following topics:

1. **Earth position in the Cosmos** -6 questions
2. **Earth (age, internal structure etc.)** -17 questions
3. **Palaeontology** -8 questions
4. **The measure of time** -4 questions
5. **Tectonics** -11 questions
6. **Earth is changing** -16 questions
7. **Natural hazards** -13 questions
8. **Natural resources and mankind** -16 questions
9. **Humans activities alter Earth** -6 questions
10. **Geodiversity, Earth protection and sustainable development** -9 questions
11. **The Earth yesterday, today and tomorrow** -10 questions
12. **Brief geological history of your region** -12 questions
13. **Geological maps** -7 questions
14. **Geology in everyday life** -3 questions
15. **Which way would you like to be taught on geosciences?** -18 questions
16. **General remarks (on local geological environment)** -14 questions

Table 1. Questionnaire's Geosciences topics

CONDUCTING THE RESEARCH

The research fieldwork, i.e. the completion of questionnaires in schools, was done during several weeks between 15th January and 29th February 2012. Questionnaires were distributed personally to 707 students and its completion lasted 50 minutes, and took place at the end of the school day. During the completion, in the classroom students were accompanied by a schoolteacher, which was informed in detail by the researchers.

Before the completion of questionnaires, the schoolteacher informed the students about the research aims and gave them oral instructions for its completion. Also, the schoolteacher explained the students that the questionnaire was anonymous and no one else could see it except GEOschools partners. No additional explanations were needed.

RESULTS AND CONCLUSIONS

The 552 students from Greece that participated in the research were students of 3rd year of High school. They had completed the two years of teaching of Geology-Geography lesson in 1st and 2nd class of High school. The 155 students from Spain were students of last (4th) year of lower, obligatory, Secondary School (15-16 years old) and from first and second year of higher Secondary School (14-17 years old).

From the interpretation of data resulting from the organisation, conduct and evaluation of questionnaires, the general interest by students in geosciences is confirmed. The most interesting subjects in total score for students from both countries are "Natural hazards" and "Palaeontology" and the less interesting "The measure of time" and the "Geological maps".

Specifically, for Greek students the most interesting subject is "Natural hazards" followed by "Palaeontology". For Spanish students in turn, the most interesting topic is "Palaeontology", followed by "Natural hazards". Both groups give a high rate to "Teaching strategies" i.e. the way they are presented and taught the Earth Sciences.

As a whole, the total interest in all topics is higher in students from Greece than in students from Spain.
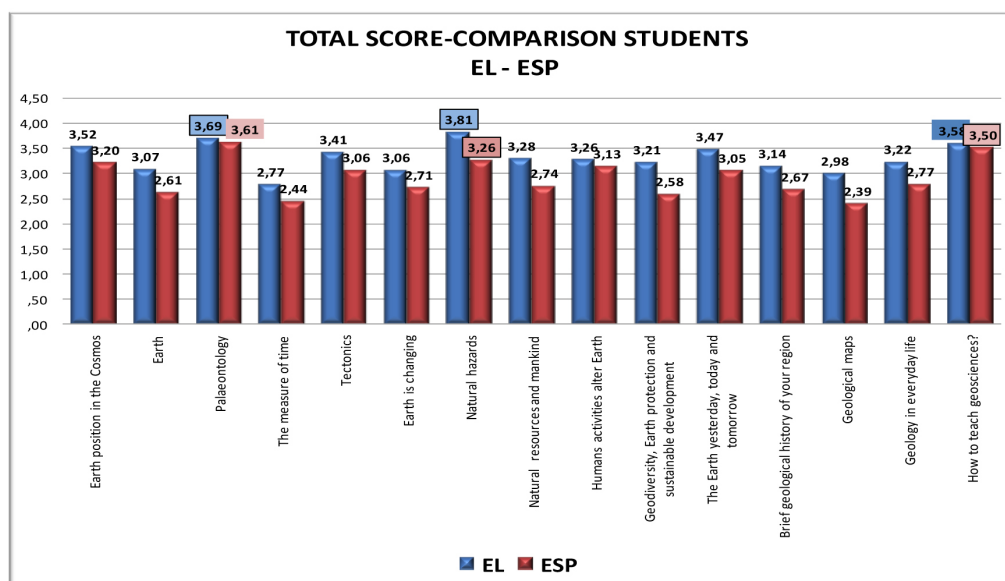

Tabla 2. *Total score comparison between Greece (EL) and Spain (ESP) in the 14 topics of the research.*

The higher score topics: Natural hazards, Palaeontology

• Natural Hazards

In the topic Natural hazards, students from both countries give the highest rate to the question concerning "Tsumani" and "Disasters from the Tsunami in Japan". The questions concerning "Earthquakes" and "Volcano eruptions" follow after. Natural hazards have also been referred as the most interesting topic for students from France and Norway by Sassier and Galland (2011). 134 students 14 and 18 years old respectively participated in this research in which natural hazards was considered the most interesting topic

Tabla 3.
Nat ards

		Earthquakes? risks and protection of the populations	Volcanic eruptions, risks and benefits of the volcanic activity	Tsunami	Japan after the hit of the Earthquake and the tsunami in March 2011	Landslides	Floods	Droughts	Storms	What we could do to avoid being exposed to Natural Hazards	How we can defend from the geological risks	Why sometimes "entire regions with villages" are sliding down from the cliffs	What happened in Pompeii after the Vesuvius eruption of 79 AD	About the eruption of Santorini volcano in the Late Bronze Age and its impact on the cultures and civilizations of the time
GREECE	N Valid	547	546	536	546	546	543	545	539	541	544	546	546	546
	Missing	7	8	18	8	8	11	9	15	13	10	8	8	8
	Mean	3,89	3,97	4,18	3,96	3,54	3,76	3,62	3,64	3,69	3,75	3,53	3,86	4,02
SPAIN	N Valid	155	155	154	155	154	155	154	155	155	155	154	154	153
	Missing	0	0	1	0	1	0	1	0	0	0	1	1	2
	Mean	3,43	3,47	3,81	3,72	2,58	2,92	2,82	3,10	3,32	3,35	2,95	3,48	3,40

The high interest of students on "Tsunami" was expected and it is attributed to recent big disasters (Earthquakes and subsequent Tsunamis in Japan, March 2011; Indonesia, December 2004, etc.). The high interest in earthquakes was expected only for Greek students, which have already felt in 89,9% an earthquake. However it was high for the Spanish students too, which haven't felt an earthquake in 88,4%. Shaw et al (2004) mentioned that a survey of school students points out that earthquake experience is not the key contributing factor for awareness. Probably this is attributed to the Mass media, which generally report very little about geosciences, but when they do, they refer to specific, violent subjects such as natural disasters, earthquakes, volcanoes, landslides, floods, tsunamis, etc.

Results also indicate that children from Greece and Spain have been in a natural disaster in 25,3% and 23,2% respectively.

There is also a further difference between Greek and Spanish students in the questions concerning historical disasters (Santorini, Pompeii). These questions have been high rated from both groups; however the Greek group has given the second higher rate of the topic to the question concerning the eruption of Santorini volcano in the Late bronze age.

• **Palaeontology**

The highest scores among the 8 items included in the topic palaeontology were obtained by the question "why dinosaurs disappeared" (which is the highest rate for the current research) followed by "the evolution of mankind" and for the Spanish students "the evolution of mankind" followed by the question concerning "dinosaurs". Trend (2007) has also referred that 'big events' constitute the most popular geosciences topic and in a research that carried out in UK the item ("dinosaur extinction event") was ranked the highest by both girls and boys, in secondary schools. It appears, therefore, that dinosaur extinction event can be seen as a unifying topic, which enables children to become interested in concepts addressing the deep past, extreme events and global environmental future.

		When and how Life appeared on Earth	About the evolution of life	How fossils are formed	Some examples for Proterozoic, Paleo-, Meso- and Cenozoic fossils	Why species go extinct	About mass extinctions	Why dinosaurs disappeared	The evolution of mankind
GREECE	N Valid	544	545	539	543	544	542	545	544
	Missing	10	9	15	11	10	12	9	10
	Mean	4,04	3,86	3,00	2,86	4,07	3,82	4,22	4,12
SPAIN	N Valid	154	154	154	152	155	155	155	154
	Missing	1	1	1	3	0	0	0	1
	Mean	3,91	3,42	2,77	2,68	3,61	3,48	4,10	4,16

Tabla 4. Palaeontology

Both questions are followed by two clarifying, related questions "When and how life appeared on Earth" and "why species go extinct".

Teaching strategies

Students show a high interst on teaching strategies. It is the secont higher topic for Spain and the third for Greece. Both student groups choose from the 17 suggestions of teaching strageties the "experiments" as the most intersting teaching strategy. "Simulations" and "fieldtrips", in this order are the next preferred topics for Greek students whilst for the spanish students the preferred order was the reverse, i.e. "fieldtrips first and simulations after".

		Attending lectures (through pupils centralized teaching activities like role play, debate, etc.)	Attending lectures (through teachers' centralized teaching)	Participating in geological activities in the field like geotrails etc.	Reading books	Seeing films and animation videos	Interact with digital simulations	Making Experiments in Laboratory	Interact with analogic model simulations	Seeing minerals and fossils in a microscope	Making geological excursions (fieldtrips) to see geology in Nature	Collecting fossils	Visiting mines and collecting minerals	Visiting protected Natural areas	Working in teams in the class	Participating in project work	Visiting geological museums	Visiting open air geological museums
GREECE	N Valid	152	154	152	153	154	154	153	153	153	154	151	154	154	154	153	153	152
	Missing	3	1	3	2	1	1	2	2	2	1	4	1	1	1	2	2	3
	Mean	3,06	2,69	4,10	2,59	3,79	3,71	4,12	3,43	3,85	3,90	3,05	3,59	3,77	3,64	3,51	3,33	3,60
SPAIN	N Valid	541	540	538	533	524	533	532	537	540	539	532	535	534	529	531	533	534
	Missing	13	14	16	21	30	21	22	17	14	15	22	19	20	25	23	21	20
	Mean	3,44	2,60	3,66	2,80	4,05	3,93	4,17	3,68	3,88	4,02	3,52	3,74	3,89	3,64	3,61	3,71	3,75

Tabla 5. *Teaching strategies*

Interest in natural sciences: Biology, Chemistry, Geology, Physics

During the past two decades, research in different areas of science education has substantially contributed to discussion about the role of interest in learning and human development in modern societies. The recognition of interest as a component of scientific literacy in the framework for Programme for International Student Assessment (PISA) 2006 provides an opportunity to broaden our knowledge in this area. School helps students discover which areas and topics they are enthusiastic about, what they would like to work on themselves, and in which topics they would like to get more involved; both in education and future professional life (Krapp & Prenzel, 2011).

Concerning students' interest in natural sciences, Greek students rated with the same score biology and physics followed by geology and chemistry with the same rate. The Spanish group showed a higher interest on biology, followed by chemistry, physics and geology (Table 6).

Among Greek students 68,6% would like to have a Geology subject in the school but only 22,9% would think about studying Geology in the university. They instead recognize in 78,2% that geology is useful for other scientists and technicians (engineers, biologists, conservationists etc.) and 73,8% accept that basic geological knowledge is useful for everyday life of people. On what concerns the local geological knowledge, 88,1% don't know the different types of rocks in their region and 93,3% don't know the age of the rocks of their region.
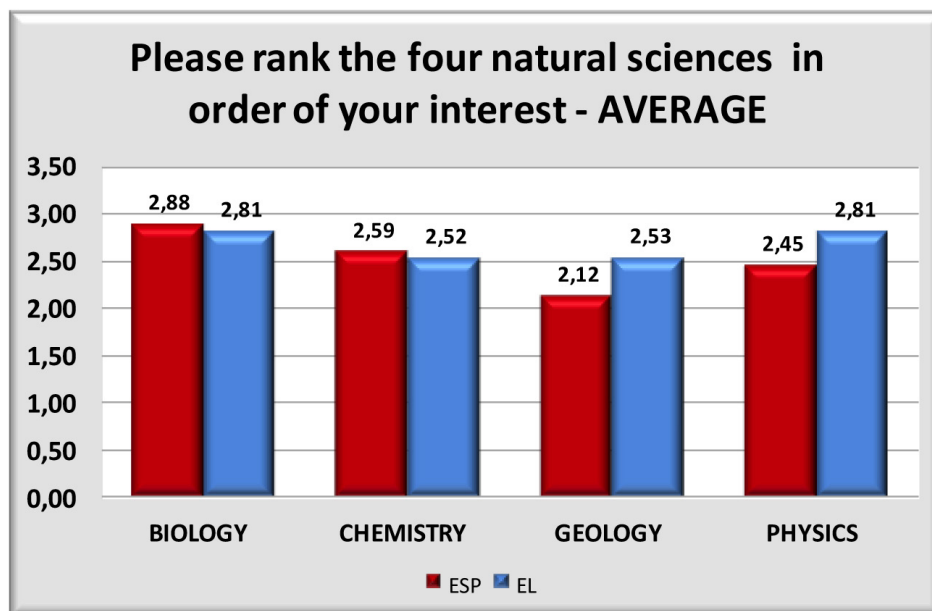
Please rank the four natural sciences in order of your interest - AVERAGE

	BIOLOGY	CHEMISTRY	GEOLOGY	PHYSICS
ESP	2,88	2,59	2,12	2,45
EL	2,81	2,52	2,53	2,81

Tabla 6. Natural sciences interest for Spanish (ESP) and Greek (EL) secondary school students.

Spanish students are less inclined to have a Geology subject in the school (32,9%) and only 15,6% would like to study Geology in the university. However, they also recognize in a high percentage (75,5%) that geology is useful for other scientists and technicians (engineers, biologists, conservationists etc.) and accept in 66,5% that basic geological knowledge is useful for everyday life of people. The knowledge of local geology throws almost similar results as in Greek students: 69% don't know the type of the rocks in their region and 93,5% ignore the age of the rocks of their region.

CONCLUSIONS

After these preliminary results of what is planned to be a wider topic interest research by secondary school students in more European countries, it seems obvious the relevance of this sort of poll studies and statistical approaches on the students' interest on Earth Sciences. Some results, which point directly to linking the higher interest of students on those topics having a higher social impact (mass extinctions, dinosaurs, geological hazards and disasters, origin of life, origin and evolution of mankind…) should perhaps make us think on the convenience to drive the curricula contents and teaching strategies towards these "interest topics" rather than trying to follow an excessively rigid, or academic, development of teaching programs. However, it can also be argued that good science and good knowledge is often only very partly

known and understood by the society. Instead, those topics being preferably treated by the Media are usually the most accepted, known and preferred by the general population, most particularly by children and young students. The challenge would be how to combine a good structural and conceptual teaching of Earth Sciences with permanent links to attractive interesting topics, i.e. making Earth Sciences something present and related to daily life or, in other words, decode the most spectacular and interesting topics so they can get the basic scientific concepts that lie behind. This could be expressed as how to build pleasure or delightful learning from good, academic teaching.

ACKNOWLEDGEMENTS

REFERENCES

Calonge, A. (2011). Curriculum comparison research: GEOschools programme, 7p.

In:http://geoschools.geol.uoa.gr/pdfs/FinalRemarksCvComparison_EN.pdf

Calonge, A. 2012: GeoSchools: una ventana abierta a la enseñanza de la Geología. In: II Conferencia del Proyecto GeoSchools: Geología y Sociedad: Alfabetización Geocientífica. Eds: A. Calonge, G. Fermeli, Mª D. López Carrillo, G. Meléndez. Publ. Seminario de Paleontología de Zaragoza, 10, 7-10. Zaragoza.

Cohen, L., Manion, L. 1998. Research methods in education Methodology, 4th ed., London & New York, Routledge, 543p.

Fermeli, G. (2011). Geosciences teaching in Greece: GEOschools programme. 9p.

In:http://geoschools.geol.uoa.gr/pdfs/Geosciences_Curricula_Greece_EN.pdf

Fermeli, G., Meléndez, G., Calonge, A., Dermitzakis, M., Steininger, F., Koutsouveli, A., Neto de Carvalho, C., Rodrigues, J., D'Arpa, C. and Di Patti, C. (2011a). GEOschools: La enseñanza innovadora de las ciencias de la Tierra en la escuela secundaria y la concienciación sobre el patrimonio geológico de la sociedad. In Fernández-Martínez, E. y Castaño de Luis, R. (Eds.). Avances y retos en la conservación del Patrimonio Geológico en España. Actas de la IX Reunión Nacional de la Comisión de Patrimonio Geológico (Sociedad Geológica de España). Universidad de León, 120-124.

Fermeli, G., Steininger, F., Meléndez, G., Dermitzakis, M.,

Calonge, A., D'Arpa, C., Di Patti, C., Koutsouveli, An., Neto de Carvalho, C., Rodrigues, J. (2011b). GEOschools - teaching geosciences in secondary schools. Geophysical Research Abstracts, Vol. 13, EGU 2011- Abstract, 1 p.

Krapp, A., Prenzel, M. 2011. Research on Interest in Science: Theories, methods, and findings, International Journal of Science Education. 33.1., 27-50.

Oppenheim, A.N. 1992. Questionnaire design, interviewing and attitude measurement. New edition, London, Pinter. 303p.

Paraskevopoulos, I. N. 1990. Statistical applied in the sciences of behaviour, v. A, B, C (in Greek), Athens, University of Athens, 208p.

Paraskevopoulos, I. N. 1993. Methodology of Scientific research, v. 1, 212p. & 2, 191p.(in Greek), Athens, University Athens.

Rodrigues, J., Catana, M. (2011). Geosciences teaching in Portugal GEO schools programme, 8p. In: http://geoschools.geol.uoa.gr/pdfs/Geosciences_Curricula_Portugal_EN.pdf

Sassier, C., Galland, O. (2011). To capture student interest in geosciences, plan an adventure. Eos, 92.1, 1-2.

Shaw, R., Shiwaku, K., Kobayashi, H., Kobayashi, M. (2004). "Linking experience, education, perception and earthquake preparedness", Disaster Prevention and Management, 13.1., 39-49.

Trend, R. (2007). Individual, situational and topic interest in geoscience among 11 and 12-year old children, Research Papers in Education, 20.3., 271-302.