

Students' interest in geoscience topics, contexts and methods

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Summary

Geoscience topics are playing an increasingly important role with regard to the future of our planet. Consequently, they have been moving into the educational foreground because of their societal relevance. The question is, however: Are pupils interested in these topics? This is important didactically, for interest is both a prerequisite and a goal of any effective learning process. What are the topics and methods that will interest students and what are those that will not? What contexts are particularly suitable for introducing children and adolescents to geoscientific topics and methods? Do pupils show a private interest in geoscientific issues? A questionnaire was submitted to 333 German senior grammar school students aged between 17 and 19. The study generally shows a medium interest in geoscientific topics with students. The most interesting topics are those that are related to human beings or environmental threat, respectively, such as "earthquakes" or "climatic changes". The interest in a topic correlates with the context that it is related to. Young adults share a relatively high interest in the topics "individual", "society" as well as "social responsibility". Concerning special methods in class there is a particular tendency towards action-oriented working methods like the carrying out of geoscientific experiments. In their spare time youths seldom occupy with geoscientific subjects. This underlines the important role of school lessons in raising the student's interest in these fields. In German school geography covers geoscientific contents far more than biology, while chemistry and physics insufficiently deal with them.

Geography and Geoscience Education in Germany

Geoscience is not a subject in the German curriculum. In Germany, geography is regarded as a so-called central subject covering all branches of geoscience (e.g. Alfred-Wegener-Stiftung, 1996: 9; KAMINSKE, 1996: 16; KÖCK, 1991: 26; KÖCK, 1992: 184; RICHTER, 1996). Its sco-

pe includes not only topics and methods from the science of geography but also selected information from other geosciences such as, for instance, geology, geophysics, and pedology. The German school subject geography covers physiogeography as well as human geography in about the same proportion. In some federal states (Bundeslän-

dern), the share of human geography is higher than in other states. In Germany, geography lessons are compulsory for students between the age of 10 and 16. The number of lessons per week varies from state to state and also depends on the kind of school the students visit. In the last two years, the students can decide between different subjects, including geography.

Biology, physics, and chemistry education also touch upon certain geoscientific contents and methods. In these lessons, geoscientific phenomena are mostly used as a context for introducing scientific laws. The focus of this Study is on the interest of students in geoscientific topics in the narrower scientific meaning of the term, while points of human geography as well as regional issues dealt with in geographical education were left out of consideration.

State of Research

In the 1980s and 1990s, a number of interest studies were conducted on the basis of the interest theory for a number of subjects, with the emphasis on science instruction (cf. e.g. HÄUSSLER, 1987; HÄUSSLER et al., 1998, on physics; LÖWE 1987, VOGT 1998 on biology).

These studies revealed that the students had only little interest in subjects related to natural science, especially in physics. However it became also clear that their interest increased as soon as the topics were presented in a context of health and environment. As far as we know, contrary to the subjects of natural

science, there is no broader study available concerning the interest of students in topics of geography or geosciences as a school subject. DIJK and RIEZBOS (1992) covered some of these aspects by examining the interest of Dutch students in different states of the Earth.

Especially in the USA, there exist a number of studies which introduce concepts that have been designed to increase the interest of students in single geoscientific topics (e.g. DUTROW 2004, O'CONNELL 2004). However, these studies are not based on a comprehensive survey on students' interests. Meanwhile, numerous studies have been conducted in Germany which present a rather comprehensive picture of the students' interest in the topics, regions, and methods of geographical education (HEMMER and HEMMER, 1996, 1997 a b c, 1998, 2002; OBERMAIER, 1997; M. HEMMER, 2000).

At about the same time, GOLAY (2000) carried out studies in Switzerland which showed that physiogeographical topics like earthquakes, vulcanism, the dying of forests and the greenhouse effect are on top of the list as far as the interest of students is concerned. However, the examined aspects had not been contextualized in these studies. A study which on the one hand concentrates on geoscientific and physiogeographical contents and on the other hand additionally links these contents with specific contexts has not existed until recently. Its results are vital as they provide exact information in how far geoscientific or geographical education can be de-

signed according to the interests of students.

The Study

In the summer of 2001 we proceeded the study in Germany. A questionnaire was submitted to senior grammar school students aged between 17 and 19. A total of 333 respondents including 171 boys and 162 girls were questioned.

The study presented in this paper forms part of a project called 'System Earth' coordinated by the Leibniz Institut für Pädagogik der Naturwissenschaften (IPN) in Kiel, Germany.

With a scheduled lifetime of five years, this interdisciplinary project is designed to contribute towards giving pupils, mainly senior pupils, a comprehensive grounding in scientific knowledge and a fundamental understanding of the complex system called earth. While this goal is fully consistent with the efforts that have been going on for a decade in the didactics and practice of geography as a curricular subject to strengthen the physio-geographical and geo-ecological content of German geographical education, its interdisciplinary approach raises the project beyond that plane. This is partly due to the fact that there is an increasing trend in some of the German Länder to establish interdisciplinary courses for students at grammar schools. The systematic concept on which the project is based is nothing new in the didactics of geography, for it can be traced back to the 1950s. The development of the concept into an

independent paradigm was boosted markedly by the contributions made by Köck in 1985 and 2001.

Numerous geoscience research institutes, scientists, schools, and extra-curricular education institutions are involved in the project (see <http://systemerde.ipn.uni-kiel.de>), under which a variety of teaching concepts and materials were developed and tested to facilitate systematic interdisciplinary instruction at the upper secondary level as well as basic teaching at the primary level. In addition, the project is supported by a number of scientific educational studies, one of which was commissioned specifically to investigate the interests of students, a matter which is of outstanding importance with regard to the development of teaching modules and materials.

The Theoretical Basis and Methods of the Interest Study

The Study is based on the theory of interest evolved in educational psychology (cf. SCHIEFELE et al., 1983; PRENZEL, 1988; KRAPP and PRENZEL, 1992; RENNINGER, HIDI and KRAPP, 1992; KRAPP, 2002). From the didactic point of view, interest is both a prerequisite of any learning process as well as an objective of instruction. Interest is defined as a person-object reference and comprises different dimensions like for example interest in topics and methods related to objects.

Next to a situative (= immediate) interest, individual (= long-term) interest plays a particularly crucial role in determining an individual's learning performance and his readi-

ness to engage in lifelong learning. Among other things, the interest study that accompanied the project was designed to determine whether pupils are interested in certain geoscientific topics of their own accord, and/or what contexts and activities might serve to promote their interest in these matters. The basic assumption was that situative interest may be motivated even in the absence of individual interest if the subject and the environment in which it is taught are attractive and inspiring. Furthermore, it was similarly assumed that addressing a subject repeatedly under those conditions may lead to the development of a robust individual interest. Empirical investigations have shown that learning supported by personal interest tends to enhance the quality of learning strategies. Knowledge is elaborated instead of merely being learned mechanically by rote. What is more, learning sup-

ported by interest will enhance the performance of individuals in acquiring knowledge and retaining it for a longer time.

Following the IPN's interest study on physics instruction (cf. HÄUSSLER et al., 1998), a three-part questionnaire was developed which in the first part uses specific categories to characterise dimensions of interest (topics and activities). For each of the eleven topics investigated (subsystems of the earth system, the carbon cycle, rocks and minerals, fossil resources, the soil, gas hydrates, the sea, drinking water, earthquake, climate changes, and changes in biodiversity), eight different context dimensions were formulated to present the subject in a more individual, societal, normative, systemic and/or non-systemic, geological, spatial, or methodological context (cf. Table 1, Table 2).

In the second part of the questionnaire, interest in the eleven topics

Table 1: Contexts and topics

Contexts	Topics
K 1 Individual concern	G 1 Earth subsystems
K 2 Societal relevance	G 2 The carbon cycle
K 3 Normative/social responsibility	G 3 Rocks and minerals
K 4 Systemic	G 4 Fossil resources
K 5 Non-systemic/technical	G 5 The soil
K 6 Geological	G 6 Gas hydrates
K 7 Spatial	G 7 The sea
K 8 Scientific methodology	G 8 Drinking water
	G 9 Earthquake
	G 10 Climate changes
	G 11 Biodiversity changes

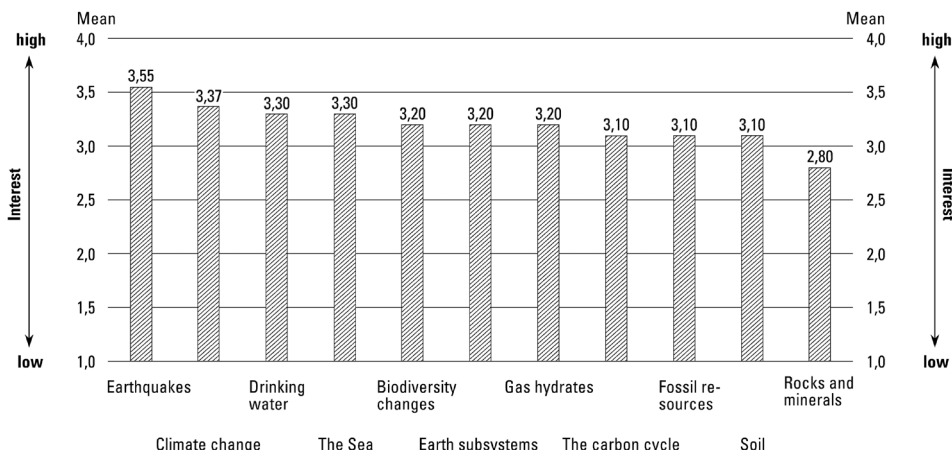


Figure 1: Students interest in specific geoscientific topics

and eight contexts was analysed separately. Next to the students' interest, the question of how exhaustively each of the topics had been dealt with in geography, biology, physics, and chemistry education was addressed as well. The conclusion was a survey of students' interest in six different learning activities ranging from the passive absorption of information to the independent procurement and evaluation of data in expert hearings, excursions, etc. Finally, the third part of the questionnaire was concerned with private occupation with geoscience matters, the objective being to learn how exhaustively and eagerly pupils look into earth science issues after school.

Report of Selected Results Students' Interest in Specific Topics

The interest shown by students in the eleven topics mentioned in the first part of the questionnaire was

generally of medium intensity, independently of the topic-context combination. The topics that respondents found least interesting were 'rocks and minerals', 'the carbon cycle', and 'the soil', while the greatest interest was shown in 'earthquake', 'climate changes', and 'the sea' (cf. Fig. 1).

While no significant gender-related differences were found with regard to half of the topics listed, the interest shown by girls in 'the soil', 'drinking water', 'earthquake', and 'biodiversity' was significantly stronger. Boys, on the other hand, displayed significantly greater interest in 'fossil resources', and 'gas hydrates'. If all topics are taken together, no gender-related differences emerge. The third part of the questionnaire included an open question about what specific topics respondents were particularly interested in. From the answers to that question, the following topics emerge, ranked by the frequency with which they were

Table 2: Sample topic-context combinations from the 'earthquake' topic

G9 Earthquakes The Lithosphere (Earth's crust and outer Earth's mantle) consists of numerous plates which are driven and therefore moved by convection currents which proceed inside the Earth. This process is repeatedly causing earthquakes at the edges of the Earth plates.						
	My interest in learning more about is	very great	great	medium	small	very small
G9K1	... whether there could be earthquakes in my region					
G9K2	... how a possible collapse of houses can be prevented in regions with a high risk of earthquakes					
G9K3 whether projects on the protection against earthquakes in poor countries should be supported by the German government					
G9K4	... why seaquakes can still cause a tidal wave at the coast despite a distance of thousands of kilometres					
G9K5	... how an earthquake develops					
G9K6	.. whether there have already been earthquakes in ancient times					
G9K7	... which regions in Europe are especially endangered for earthquakes					
G9K8	.. how the centre of an earthquake can be located from any other point on the Earth					

mentioned: plate tectonics, volcanic activity, interaction (man-earth, etc.), natural disasters, destruction of the environment, individual topics relating to the biosphere, the atmosphere, and the hydrosphere, the development of the earth, interstellar space, and anthropogenic aspects.

Students` Interest in Contexts

Considered separately, the interest shown by the pupils in the various contexts (cf. Table 1, 2; Fig. 1) presents the following picture: All respondents showed relatively high interest in the following contexts: ,individual/personal concern` (K1), ,societal relevance` (K2), and ,social responsibility` (K3). Girls displayed a significantly stronger interest than boys in contexts K1, K3, and K4 (interaction between geofactors), while the interest displayed by boys in the context of ,geoscience methodology` was somewhat stronger, but not significantly so.

As mentioned above, ,climate change` is a topic that meets with relatively strong interest among all the young people, most especially in the context of ,individual concern` (K1), ,systemic aspects` (K4), ,geoscientific research` (K5), and ,spatial view` (K7). Rated as relatively devoid of interest as a whole, the topic ,rocks and minerals` met with greater interest among both boys and girls when presented in the context of ,geology` (K6) and ,societal relevance` (K2). Among boys, the context of ,economic significance` (K2) similarly tended to arouse greater interest.

Interest in a specific topic changes significantly concerning the context to which it is related. Thus, for instance, the carbon cycle proved more interesting when related to the individual than in its scientific context. Moreover, interest in any given context will vary depending on the topic to which it is related. Thus, the methods employed by earth scientists appear highly interesting in conjunction with the earthquake topic, while pupils show relatively little interest in geoscientific methodology where soil analysis is concerned.

Students` Interest in Methods

As far as teaching methods are concerned, it was found that respondents were particularly interested in practical activities such as, excursions to gather data, or geoscientific experiments. Besides, respondents displayed an outstanding interest in acquiring information through images and films. Interest in these activities was significantly higher compared to any other method. Very likely, the visual appeal of images and/or films is crucial to the way in which these media are received. Listed in descending order, the teaching methods which pupils found comparatively uninteresting include listening to teachers' lectures, evaluating scientific data, assessing research findings, and talking with others about geoscientific research.

Asked about their interest in students listed the following priorities: guided tours through a research institute or institution, visits to ex-

hibitions and museums, running their own experiments in a research institute, and listening to presentations by geoscientists.

The Importance of Different School Subjects

We also examined how exhaustively geoscientific topics were being dealt with in biology, chemistry, geography, and physics lessons. Ranging between 1 = ‚none‘ and 2 = ‚little‘, the mean value of 1.59 derived from the averages of all topics and subjects underlines the marginal nature of the coverage of geoscientific topics at school. A breakdown by subjects shows that the coverage of geoscientific issues is most extensive by far in geography lessons (mean value = 2.65), followed by biology (2.10), chemistry (1.60), and physics (1.32). A breakdown by topics shows that geography clearly dominates in the coverage of nine topics, while the role of chemistry and physics education in transporting geoscientific knowledge is diminutive in Germany. Moreover, the eleven topics listed by no means include all geoscientific subjects that are of relevance in school education. Thus, for instance, topics such as ‚volcanic activity‘, ‚plate tectonics‘, ‚glacial processes‘, and ‚climatological phenomena‘ are not included as they have been traditionally covered in geography lessons. If this fact is taken into consideration, the conclusion is inescapable that in Germany, geography may justifiably claim to be the subject to teach geosciences.

Occupation with Geoscience Topics During Leisure Hours

The questionnaire inquired additionally the extent to which students occupied themselves privately with any of the different topics under consideration. In addition, they were asked about how they would rate their own knowledge in these fields. Leisure-time occupation as well as the students' estimates of their own knowledge may be used as indicators of individual interest. Results show that young people hardly occupy themselves at all with the topics under discussion during their leisure hours, and that their knowledge is consequently low. The topics with which they most frequently occupied themselves in private were ‚drinking water‘ and ‚the greenhouse effect‘, and these were the two areas in which the young people rated their knowledge most highly. The topics least favoured by them were ‚the carbon cycle‘ and ‚rocks‘ as well as ‚gas hydrates‘. Once again, these results corresponded with the young people's own estimate of their knowledge, the sole exception being the subject of ‚rocks‘ where the young people rated their own knowledge rather more highly.

All in all, students tend to occupy themselves with geoscience issues only rarely in their private lives, although the mean value for boys at 2.44 is significantly higher than that for girls (2.15).

Summary and Discussion

Given a medium overall level of interest in geoscientific topics, the differences between the individual topics are marked. Most interesting are those topics that are inherently related to humankind and/or to life, living beings, and environmental hazards, such as, for instance, earthquakes, climate changes, and the sea. The results obtained by HEMMER and HEMMER (1996a) are of a similar nature. Having questioned about 2,900 respondents aged between 10 and 17, they were able to establish that interest is particularly high in issues that relate to people's daily lives or to aspects of environmental relevance.

Regarding the contexts within which topics may be addressed, the young people stated that they were particularly interested in 'individual concern', 'societal relevance', and 'social responsibility'. Consequently, maximum interest ratings may be obtained by combining these three contexts with the topics rated above as being most interesting. These results corroborate the findings obtained with regard to physics and geography instruction. HÄUSSLER et al. (1987) similarly found that physics instruction appeared most interesting in an environmental, health, or individual context.

This being so, teachers may crucially influence their students' interest by their selection and legitimation of a topic as well as by integrating it in a suitable context. As a general rule, interest is encouraged by linking a subject to the students'

everyday experiences out of school, and/or by establishing a traceable connection to the realities of their lives. In this way, the benefit and significance of a subject for the individual as well as for the society as a whole is rendered transparent and palpable.

The high level of interest in action-oriented methods established in this Study is similarly corroborated by an earlier study which found, by investigating interest levels and methods in geography education, that children and adolescents show a greater interest in methods and media that permit hands-on contact or have some activity potential (cf. HEMMER and HEMMER, 1997b). These findings may be put to good use in school by combining topics in which young people are not greatly interested, such as the soil, with interesting teaching methods, such as experiments. In addition, personal contacts with scientists as well as visits to research institutes and other extramural institutions of learning are attractive to pupils.

As in the former studies of interest in geography and other subjects named above, gender was found to be an important independent variable in this study as well (cf. HEMMER and HEMMER, 1996b; HOFFMANN et al., 1998). Knowing the different preferences of girls and boys and integrating that knowledge positively in their lessons is an important challenge to teachers when dealing with geoscientific as well as with other topics.

The role played by individual sub-

jects in transporting geoscientific knowledge is anything but uniform in Germany. As far as chemistry and physics are concerned, it must be said that the potential of using geoscientific phenomena as contexts is far from being fully exploited at present. Biology instruction, too, needs to catch up in this respect. Regarding geography, the fact is that the links to the aspects of nature and man that are immanent in the subject are clearly consonant with the interests of the students. The results of this Study emphasize that geography in Germany is indeed the central subject for transporting geoscientific contents.

Those results of the study which demonstrate that private occupation with geoscientific topics is rare merely serve to underline the importance of geography or geoscience lessons in arousing interest in these thematic areas.

This study was extremely important for Germany in order to develop professional interest oriented modules within the framework of the major project titled 'System Earth Research Dialogue'. These modules have been published recently and are available on CD-Rom (mail: gessner@ipn.uni-kiel.de). A downloadable version of the modules will soon be available on the website of the Kiel university: <http://systemerde.ipn.uni-kiel.de>. From an international point of view, this study not only draws the attention to the significance of the students' interests but also enables us to give specific instructions for the planning

of interest oriented teaching since the study provides us with precise information on this matter as far as geoscientific contents are concerned. From our point of view, it might be an interesting opportunity for the scientific community, to carry out interviews with the same research tool to determine similarities and differences in the student's interests in an international comparison.

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GuiD 35. Jg., 2007, Heft 4

GEOGRAPHIE und ihre DIDAKTIK

4
07

Journal of Geography Education

E 11420

ISSN 0343-7260

Inhalt

- Fostering progress in children's developing geoscience interests (R. Trend)
- Students' interest in geoscience topics, contexts and methods (I. Hemmer & al.)
- Student's conceptions on circadian and seasonal cycles (S. Weizinger/ I. Hemmer)
- Misleading analogies that lead to the belief that the mantle of the earth is liquid (J. Sellés-Martínez)
- Students' concepts about meteorite impacts on earth – geographical assessment and pedagogical consequences (M. Müller)
- Educational reconstruction – a key to progress in geoscience teaching and learning (S. Reinfried)
- A Design-based Research of an Oceanography Module as a part of the Israeli High School Earth Sciences Program (N. Orion/C. Cohen)
- E-learning in the geography, earth and environmental sciences disciplines: practitioner perspectives from the united kingdom (D. France/ S. Fletcher)
- Educating science teachers in earth science teaching: the Earth Science Education Unit initiative in England and Wales, and its transfer to Scotland (Ch. King/S. Lydon)
- Enactment of a geoscience curriculum by using innovative curriculum materials - an exploratory case study (H. Hansen/S. Hlawatsch/M. Lücken)
- A geoscientific approach to the PISA 2006 framework of scientific literacy (S. Rönnebeck)

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Druck: krea.druck, Bindlach

Bezugsbedingungen: Erscheinungsweise vierteljährlich. Jahresabonnement für Privatpersonen 15 €, für Institutionen 24 €, Einzelheft 6 €, jeweils zuzüglich Versandkosten. Die Abonnementsgebühren sind jährlich im Voraus nach Erhalt der Rechnung fällig. Eine Kündigung kann jeweils spätestens ein Vierteljahr vor Ablauf des Jahresabonnements erfolgen. Vertrieb und Bestellungen durch bzw. an die Schriftleiterin.

Hinweise für Autoren: Manuskriptsendungen an den Herausgeber. – Manuskriptgestaltung: Tahoma 10 pt., Titel 14 pt., einfacher Zeilenabstand; Zitieren durch Angabe von Autorennamen/Erscheinungsjahr/Seitenzahl(en) im fortlaufenden Text; Literaturverzeichnis in der üblichen Form mit vollständigen, bibliographisch eindeutigen Angaben; Bilder als eigene Datei 300 dpi – GuiD veröffentlicht nur Originalbeiträge.

Redaktionsschluss für Heft 1/2008 am 6.3.2008, für Heft 2/2008 am 6.06.2008
 Postzeitung-Vertriebskennzeichen E 11420 Presse Distribution Berlin

* im Auftrag des Hochschulverbands für Geographie und ihre Didaktik (HGD), Sitz Freiburg/Br. – Vorstand: Prof. Dr. I. Hemmer, Eichstätt (Vorsitzende) – Prof. Dr. M. Hemmer, Münster, und Prof. Dr. K.-H. Otto, Bochum (Beisitzer) – Prof. Dr. Gregor Falk, Freiburg (Schriftführer) – Dr. Chr. Meyer, Trier (Kassenwärtlerin)

THE Vth INTERNATIONAL GEOSCIENCE EDUCATION CONFERENCE (GEOSCIED V) IN BAYREUTH

This special edition of the German Journal "Geographie und Ihre Didaktik" contains selected contributions of the Vth International Geoscience Education Conference (GeoSciEd V). They cover important aspects of geoscience education research.

The conference took place from september 18 – 21, 2006 in Bayreuth on behalf of the Leibniz Institute for Science Education (IPN), Kiel, the Geo-Centrum at the German Deep Drilling site KTB, Windischeschenbach, and the University of Bayreuth. The conference program comprised the major dimensions of Earth science education. A great many contributions followed an interdisciplinary approach integrating geographical and geological aspects as well as biological, chemical and physical ones. This is in accord with the educational aims set by the German geoscience associations. It also corresponds with the educational approach of the IPN project "System Earth", which marks a milestone of the quality improvement of geoscience education in Germany.

The International Geoscience Education Organisation (IGEO) runs the international GeoSciEd-Conference approximately every four years, alternating with a representation at the International Geological Congress, which also takes place at four year intervals. The first conference was at Southampton in the UK in April 1993. This first conference sparked interest but it was not until 1997 that GeoSciEd was proposed as the name of the conference. IGEO was founded at that 1997 GeoSciEd II in Hawaii. GeoSciEd III in 2000 was held in Sydney, Australia and GeoSciEd IV was in Canada in 2003.

The aims of the International Geoscience Education Organisation (IGEO) are to promote geoscience education internationally at all levels, to work for enhancement of the quality of geoscience education internationally and to encourage developments raising public awareness of geoscience, particularly amongst younger people. It is affiliated with the International Union of Geosciences (IUGS).

The German conference came at an important time with the declaration of 2008 as the International Year of Planet Earth and the recognition of the significant role of geoscience education in creating a sustainable future for humans and their planet.

We are now looking forward to the VIth GeoSciEd 2010 in Southafrica.