Report on the first round of the Delphi study – Italy (UNIVPM)

1 Framework and procedure of the first round – participation rate

1.1 First attempt

In the first months of 2012, 647 participants were asked, in both digital and printed format, to fill out the PROFILES Delphi questionnaire (1st attempt); 94 participants gave feedback and sent back filled out 94 answer-sheets (see Table 1):

Tab. 1: Participants for each group and participation rate after the first attempt

Group	Subgroup		Number	Total number
Students	Students at school without advanced science courses	Biology		2
		Chemistry		
		Physics		
		Science	2	
	Students at school with advanced sciences courses	Biology		
		Chemistry		
		Physics		
		Science		
Teacher Students and trainee teachers ("young teachers")	University students in the education program	Biology		59
		Chemistry	59	
		Physics		
		Science		
	Trainee science teachers	Biology		
		Chemistry		
		Physics		
		Science		
Teachers and trainee teacher educators (experienced teachers)	Science teachers	Biology	3	23
		Chemistry	6	
		Physics	2	
		Mathematics	4	
		Science	8	
	Science traineeteacherseducators	Biology		
		Chemistry		
		Physics		
		Science		
Educators, didactics, and in-service teacher educators	Chemistry			
	Physics			
	Biology			
	General Science/Primary Science			
Scientists	Chemists			10
	Biologists			
	Physicists			
	Others		10	

As shown in Table 1, among the participants four sub-groups can be identify:
1) A sub-group of 521 scientists composed by full professors, associate professors and researchers of five different Faculties: Agriculture, Economics, Engineering, Medicine and Surgery and Sciences. The scientists were invited to give their feedback, but after the first attempt, only 10 participants gave their responses;
2) a sub-group composed by 23 experienced science teachers;
3) a sub-group of 59 university students attending the chemistry course of the Faculty of Engineering;
4) two students at school.
In reference to first attempt the duration of the data collection was about two months: February/March of 2012.
Due to a low response rate of the scientist's sub-group, we decided to send out the questionnaire a second time and the participants were asked again to answer questions. Considering both the first and the second attempt, the duration of the data collection was about four months: from February to May 2012. During this time we collected further 32 responses from other scientists, reaching a total number of 42 (see Table 2).

Tab. 2 : Participants for each group and participation rate after the second attempt

Group	Subgroup		Number	Total number
Students	Students at school without advanced science courses	Biology		2
		Chemistry		
		Physics		
		Science	2	
	Students at school with advanced sciences courses	Biology		
		Chemistry		
		Physics		
		Science		
Teacher Students and trainee teachers ("young teachers")	University students in the education program	Biology		59
		Chemistry	59	
		Physics		
		Science		
	Trainee science teachers	Biology		
		Chemistry		
		Physics		
		Science		
Teachers and trainee teacher educators (experienced teachers)	Science teachers	Biology	3	23
		Chemistry	6	
		Physics	2	
		Mathematics	4	
		Science	8	
	Science traineeteacherseducators	Biology		
		Chemistry		
		Physics		
		Science		
Educators, didactics, and in-	Chemistry			
	Physics			

service teacher educators	Biology		
	General Science/Primary Science		
Scientists	Chemists	1	42
	Biologists	7	
	Physicists	3	
	Others	31	

After the second attempt, we decided to increase the group of students, so we handed out the questionnaries to more students at school with and without advanced sciences courses, up to have a total of 44 responses. Furthermore, in this third phase, we increased the group of experienced teachers (from 23 to 28) (Table 3).

Our final sample consists of 173 participants, as follows:

- 44 Students;
- 59 Teacher Students;
- 28 Teachers and trainee teacher educators;
- 42 Scientists.

Tab. 3 : Participants for each group and participation rate after the third attempt

Group	Subgroup		Number	Total number
Students	Students at school without advanced science courses	Biology		44
		Chemistry		
		Physics		
		Science	29	
	Students at school with advanced sciences courses	Biology		
		Chemistry		
		Physics		
		Science	15	
Teacher Students and trainee teachers (“young teachers”)	University students in the education program	Biology		59
		Chemistry	59	
		Physics		
		Science		
	Trainee science teachers	Biology		
		Chemistry		
		Physics		
		Science		
Teachers and trainee teacher educators (experienced teachers)	Science teachers	Biology	3	28
		Chemistry	7	
		Physics	3	
		Mathematics	4	
		Science	11	
	Science traineeteacherseducators	Biology		
		Chemistry		
		Physics		
		Science		
Educators, didactics, and in-	Chemistry			
	Physics			

service teacher educators	Biology		
	General Science/Primary Science		
Scientists	Chemists	1	42
	Biologists	7	
	Physicists	3	
	Others	31	

2 Qualitative analysis

2.1 Method

For each of the three question a tab-sheet was developed. The tab-sheets have been divided in several categories assigned on the basis of processed responses. The scheme of the procedure adopted for the data analysis is shown in Fig. 1.

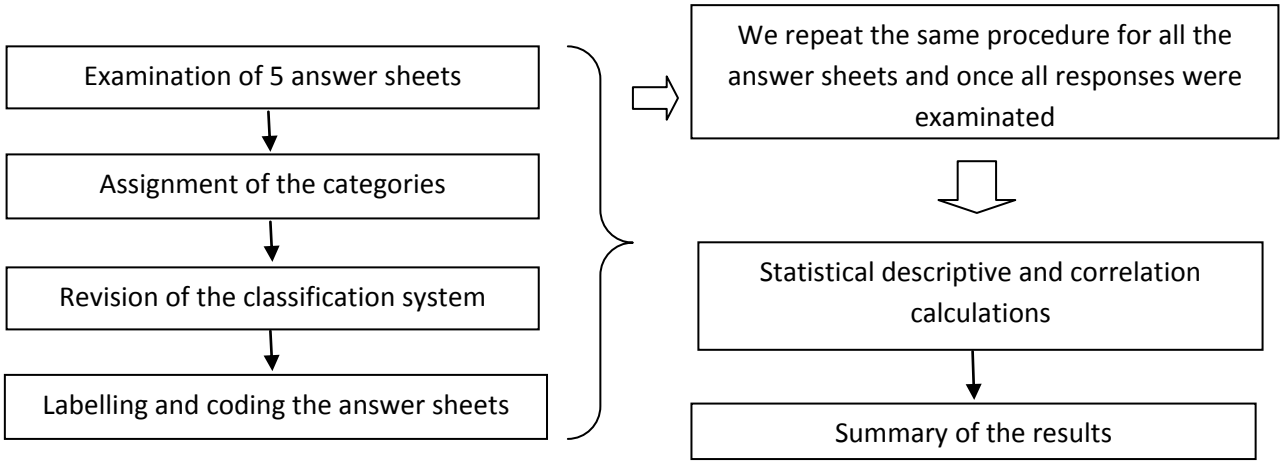

Fig. 1: Procedure of the data analysis

2.2 Results

In the following table (Tab. 4) the categories, differentiated according to the three main questions (I, II and III) and the methodical aspects (IV), are listed.
Referring to the first issue “situations, contexts, motives” twenty categories were found.
The second question was divided in two parts: (basic) concepts and topics (with 17 categories) and scientific field and perspectives (with 17 categories). For the third question “qualification”, 19 categories were found. Also, the statements referring to the methodical aspects were processed and 9 categories were identified (column IV, Tab. 3).

Tab. 4: Categories differentiated according to the questions in the questionnaire

I	II		III	IV
Situations, contexts, motives	IIa:(basic) concepts and topics	IIb: Scientific fields and perspectives	Qualification	Methodical Aspects
Education / general pers. development	Chemical reactions	Botany	(Specialized) knowledge	Cooperative learning
Emotional personality development	Energy	Human biology	Comprehension / understanding	Learning in mixed-aged classes
Intellectual personality development	Interaction	Ecology	Applying knowledge / thinking abstractly	Interdisciplinary learning
Students' interests	Development / growth	Inorganic chemistry	Judgement / opinion-Forming /reflection	Inquiry-based science learning
Nature / natural phenomena	Models	Organic chemistry	Formulating scientific questions/ hypotheses	Role play
Everyday life	Terminology	Analytical chemistry	Being able to experiment	Discussion / debate
Medicine / health	Scientific Inquiry	Biochemistry	Rational thinking / analysing /drawing conclusions	Using new media
Technology	Health / medicine	Mechanics	Working self-dependently /structuredly / precisely	Concept maps
Occupation	Matter in everyday life	Earth sciences	Reading comprehension	Self-assessment
Science - biology	Technical devices	Mathematics/physics, chemistry	Communication skills	
Science - chemistry	Environment	Interdisciplinarity	Knowledge about scientific occupations	
Science - physics	Safety and risks	Current scientific research	Sensibility / empathy	
Science - interdisciplinarity	Occupations / occupational fields	Consequences of technol. developm.	Social skills / teamwork	
Out-of-school learning	Statistics/probability	History of the sciences	Motivation / interest / curiosity	
Laboratory - Experimental activity	New technologies	Ethics / values	Critical questioning	
Interactive lesson	All science subjects are equally important	Zoology	Acting reflectedly and responsibly	
Teamwork	Main and basic knowledge	Astronomy / space system	Problem solving	
Logic			Deductive/inductive reasoning	
Periodic assessment of learning			Determination	
Rewards for best students				

2.3 Discussion

With reference to the question "Situations, contexts, motives" the obtained results show that, for the participants, the following categories are very important:

- Laboratory - Experimental activity => To do as many practical applications and experimental activities as possible;
- Everyday life => To make reference and connections to everyday life;
- Nature / natural phenomena => Explanation of natural phenomenas;
- Students' interests => Satisfy the curiosity of students by developing interesting issues;
- Teamwork => Assignment of projects to groups of students.

About the other categories, the statements are more heterogeneous, as shown in the charts represented at the point 3 of the present report.

In reference to question II, according to the participant's opinion, the main concepts and topics are:

- Main and basic knowledge => all the specific concepts related to one's studies, foundamentals of subjects;
- Matter in every day life => connections with everyday life, discussion of issues concerning the reality.

Also the technical devices, the terminology, the environment and the energy are considered important, althought to a lesser degree.

Concerning to the "scientific fields and perspectives", in general the greater importance was given to: history of the sciences, consequences of technological development, mathematics/physics, chemistry and interdisciplinary. According to the opinion of the students, the two most popular scientific fields are the human biology and the earth sciences.

About the "qualification", the participants gave several statements and among the various subgroups the opinions are heterogeneous. According to the responses provided from our sample, the students should develop the following main qualifications:

- Problem solving => learning to set and to deal with a scientific problem, learning to understand what a problem requires and learning to solve it properly;
- Critical questioning => asking questions about why certain phenomena occur;
- Motivation / interest / curiosity;
- Rational thinking / analysing /drawing conclusions => ability to organize the knowledge and to select and to distinguish the basic data;
- Comprehension / understanding => ability to reason and to make connections; ability to further develop the topics discussed;
- Judgement / opinion-Forming /reflection;
- Communication skills;
- Being able to experiment.

Finally, it shoul be noted that the methodical aspects judged more significant are:

- using new media;
- cooperative learning;
- concept maps;
- discussion/debate.

3 Quantitative analysis

3.1 Method

For the first part of the processing, we analyzed all the statements and we assigned the categories based on the key words and the concepts expressed in the answers.
The relative frequency of the categories has been determined by using Excel program.
We assigned a different form sheet to each questionnaire (I, II, III or IV) and for each participant we coded with "1" the categories mentioned and we coded with "0" the categories not mentioned. We didn't assign a statement to two different categories, but we count it only once.

3.2. Objectivity of the data analysis

All the statements are carefully analyzed and only those statements that express the same concept belong to the same category. Once analyzed the answers of about five participants, we reviewed the categories assigned to the processed statements in order ensure the objectivity and the congruence of the data analysis.

3.3 Results

In the following charts (Fig. 2, 3, 4, 5 and 6) the relative frequencies of the categories (differentiated on the basis of specific question) is shown. The results have been differentiated over the four identified sub-samples (students at school, science teacher, scientists and university students).

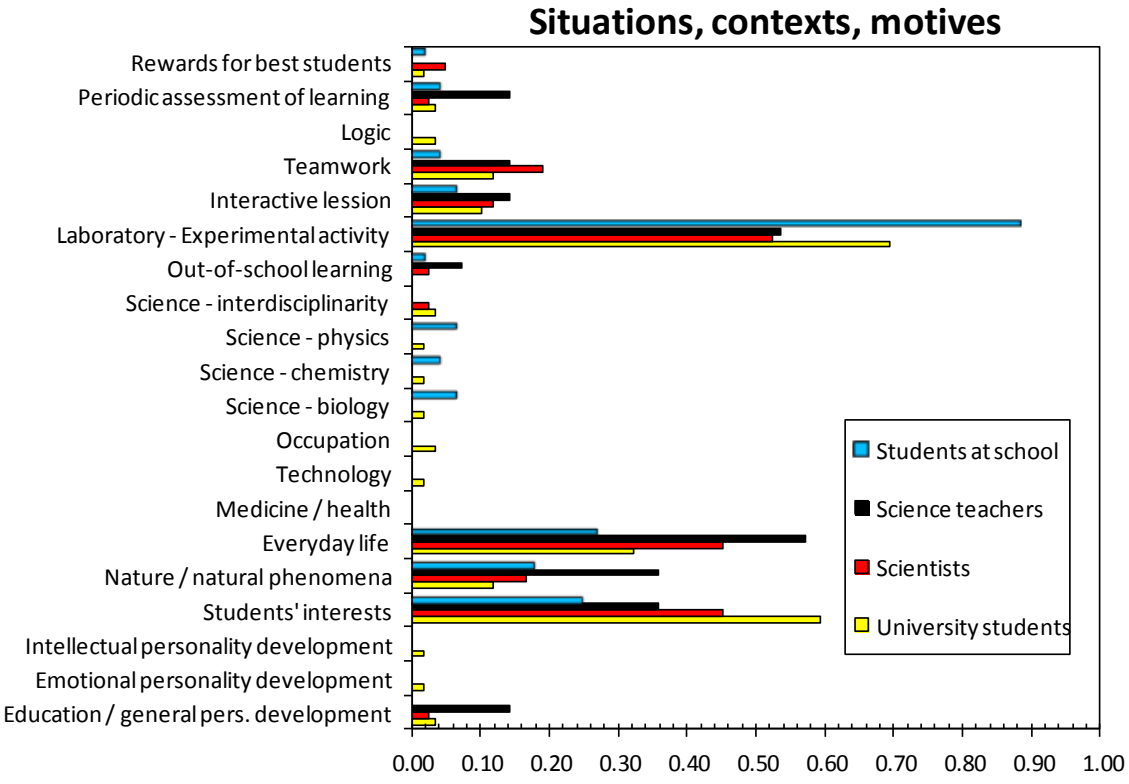

Fig. 2: Relative frequency of the categories regarding the statement bundle "situation/context/motive" – percentage of the total sample and the four sub-samples.

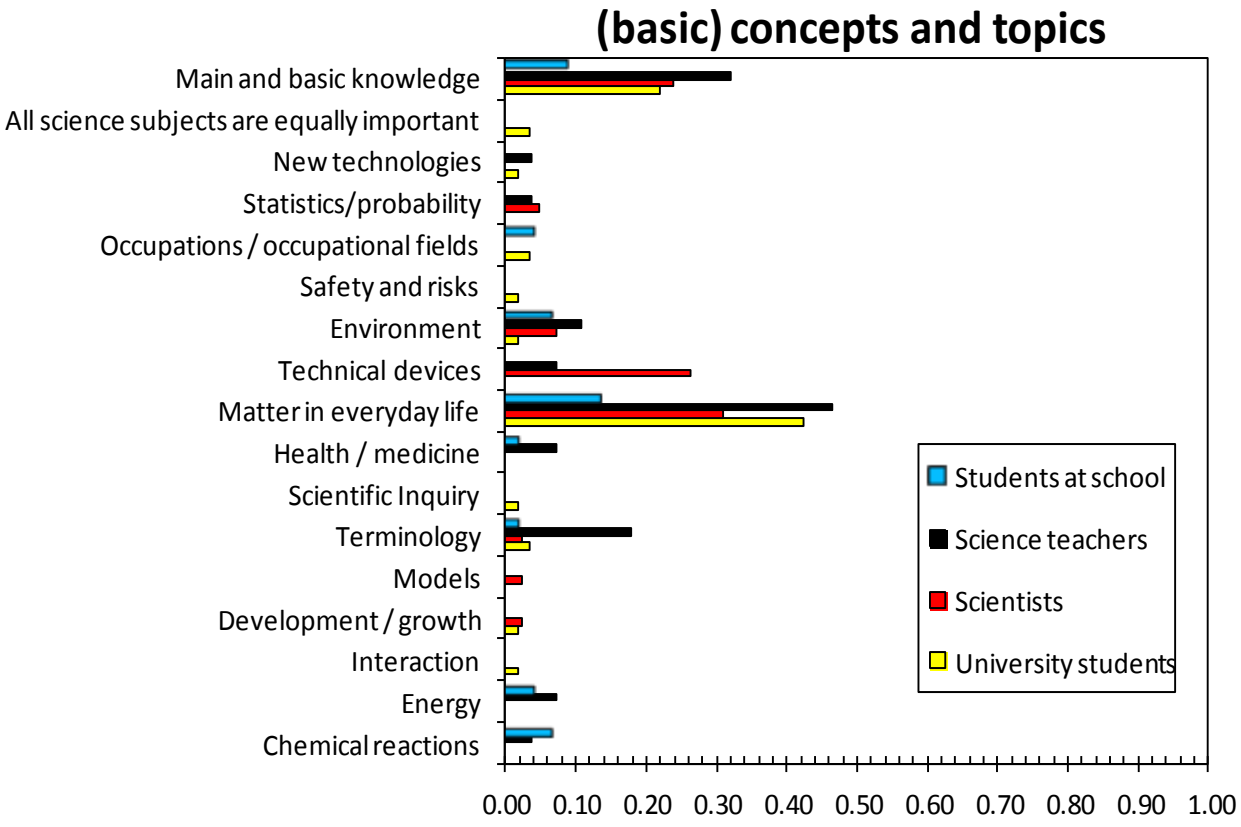

Fig. 3: Relative frequency of the categories regarding the statement bundle "(basic) concepts and topics" – percentage of the total sample and the four sub-samples.

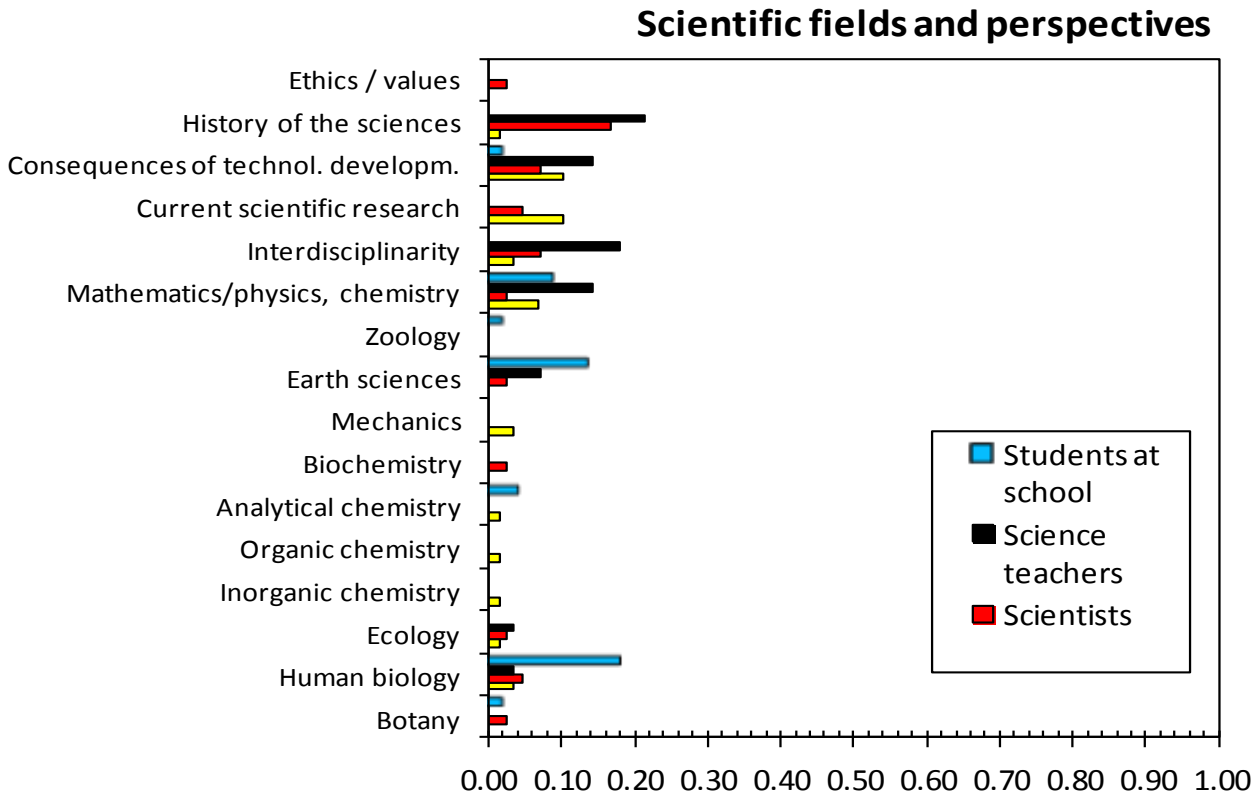

Fig. 4: Relative frequency of the categories regarding the statement bundle "scientific fields and perspectives" – percentage of the total sample and the four sub-samples.

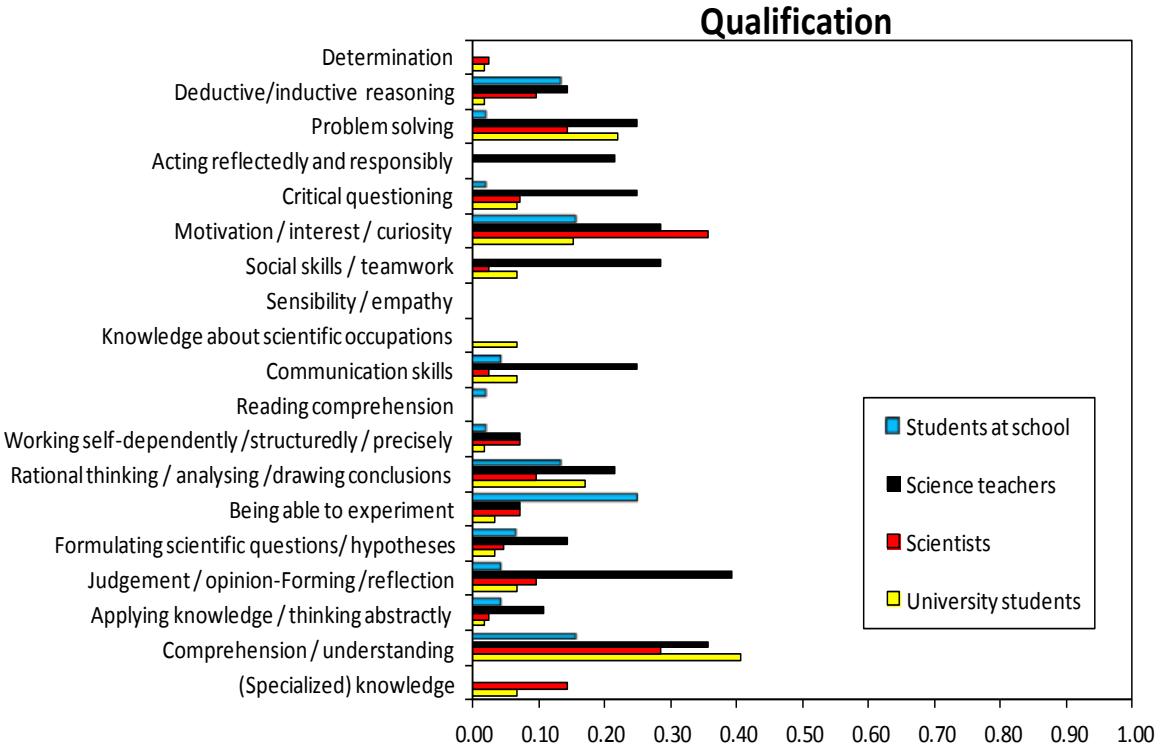

Fig. 5: Relative frequency of the categories regarding the statement bundle "qualification" – percentage of the total sample and the four sub-samples.

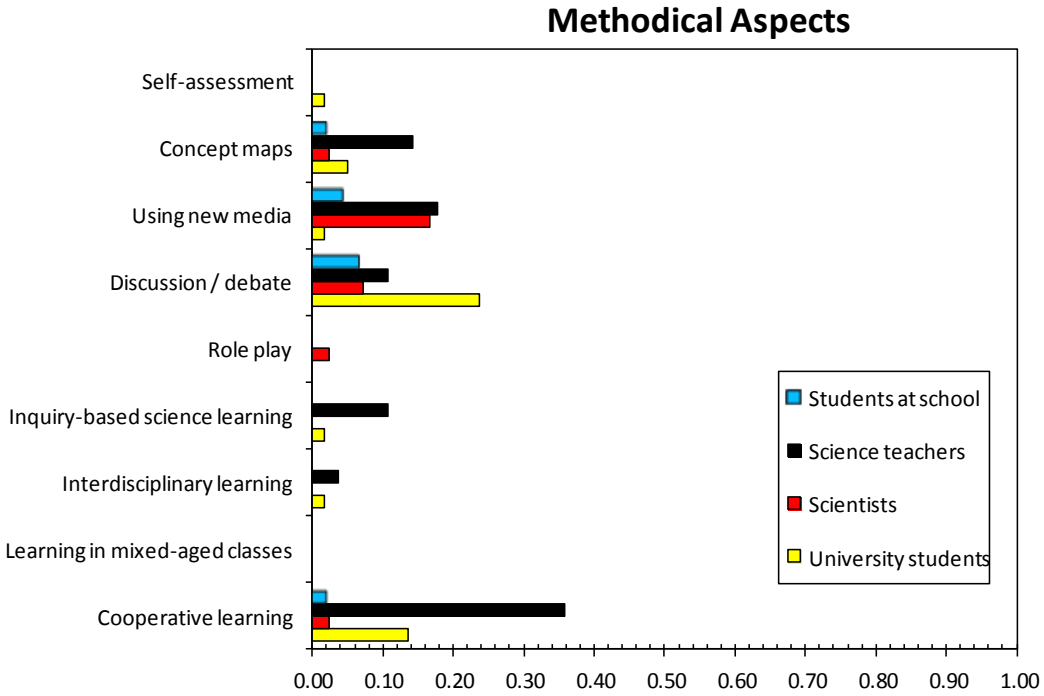

Fig. 6: Relative frequency of the categories regarding the statement bundle "methodical aspects" – percentage of the total sample and the four sub-samples.

3.4 Discussion and remarks

Based on the final results, the higher relative frequencies, differentiated for the four sub-samples and for the several questions, have been established. The main categories chosen by each sub-sample are the following:

1) Science teacher:
- Situations, contexts, motives => every day life;
- IIa:(basic) concepts and topics => matter in every day life;
- IIb: Scientific fields and perspectives => history of the sciences;
- Qualification => judgement / opinion-Forming /reflection;
- Methodical Aspects => cooperative learning.

2) Scientists:
- Situations, contexts, motives => Laboratory - Experimental activity;
- IIa:(basic) concepts and topics => matter in every day life;
- IIb: Scientific fields and perspectives => history of the sciences;
- Qualification => motivation/interest/curiosity;
- Methodical Aspects => using new media.

3) University students:
- Situations, contexts, motives => Laboratory - Experimental activity;
- IIa:(basic) concepts and topics => matter in every day life;
- IIb: Scientific fields and perspectives => current scientific research and consequences of technological development;
- Qualification => comprehension/understanding;
- Methodical Aspects => discussion/debate.

4) Students at school:
- Situations, contexts, motives => Laboratory - Experimental activity;
- IIa:(basic) concepts and topics => matter in every day life;
- IIb: Scientific fields and perspectives => human biology;
- Qualification => being able to experiment;
- Methodical Aspects => discussion debate.