Report on the second round of the PROFILES Curricular Delphi study on Science Education

Italy (UNIVPM)

Table of contents

1 Introduction 2

2 Leading questions of the second round 4

3 Method 4

4 Sample structure and form of the responses 7

5 Results of the descriptive analyses 9

5.1 Priority assessment 9

5.2 Practice assessment 15

5.3 Priority-Practice differences 20

6 Results of the cluster analyses 26

6.1 Clustering based on the cases 26

6.2 Frequency of the categories in the different clusters 29

6.3 Descriptions of the clusters 31

References 34

1 Introduction

In the first round of the PROFILES Curricular Delphi Study on Science Education written questionnaires were submitted to 173 participants and, according to the responses obtained, the categories considered more significant were identified. The questions concerned the following aspects of teaching and learning:

- I: Situations, contexts, motives;
- IIa:(basic) concepts and topics;
- IIb: Scientific fields and perspectives;
- III: Qualification;
- IV: Methodical Aspects.

It should be noted that although we asked more than 600 people to answer questions our final sample consists of about 170 participants (see Report on the First round, UNIVPM). Despite the difficulties, from the study and processing of the results many interesting categories were identified (see Table 1).

One of the main aim of this second round is to further develop the study carried out in the first round, by selecting the most significant categories for each of the four aspects. Therefore, the purpose is to identify also the major gaps that currently the scientific literacy has.

The study was aimed to the same group of participants who attended the first round, this group is divided into 4 subgroups:

- students at school;
- university students;
- science teachers;
- scientists.

This report describes the methods used and the results obtained in the second round.

Table 1: Categories identified in the first round

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

2 Leading questions of the second round

In order to assess the categories identified in the first round, in this second phase the following questions were addressed:
- what are the priorities of science education that are most important?
- what are the topics and subjects that have more relevance?
- what are the weaknesses of science teaching today?
- what are the main teachings that should be given and by what means?

The answers collected during the first study was several, but in this second round we wanted to establish a list between the various options.

3 Method

In this second round, the same participants took part in the first round were asked to answer additional questions. Participants were given a questionnaire divided into two parts. In the first part (PART I), for each of the four aspects studied in the first round, participants were asked to assess the categories according to two different points of view: “priorities” and “practice”. In particular, the following questions were asked:

- which priority should the respective aspects have in science education (priority)?
- to what extent are the respective aspects realized in current science education (practice)?

The participants were asked to code the data following a six-tier scale, ranged from 1 to 6 (1 = “very low priority”/ “to a very low extent”; 2 = : “low priority”/ “to a low extent”; 3 = “rather low priority”/ “to a rather low extent”; 4 = “rather high priority”/ “to a rather high extent”; 5 = “high priority”/ “to a high extent”; 6 = “very high priority”/ “to a very high extent”). An example regarding the PART 1 of the questionnaire is shown in Figure 1.

Referring to the first part, the data were analysed by means of descriptive and variance analytical methods, taking into account both the two different assessments individually (priorities and practice) and analysing their differences.

In the second part of the questionnaire (PART II) the participants were asked to select and to combine the categories that had been presented to them (see Figure 2). The data were processed by using an excel sheet. The selected categories were coded with the number "1", while the not selected categories with "0". The obtained results were listed in hierarchical order, identifying for each of the four aspects of interest, the first five categories deemed most important and the last five considered less relevant.

Part I: **Situations, contexts and motives** Please assess the following categories according to the two questions stated.	Which **priority** should the respective aspects have in science education? 1 = very low priority 2 = low priority 3 = rather low priority 4 = rather high priority 5 = high priority 6 = very high priority	*To what e**xtent** are the respective aspects realized in current science education?* *1 = to a very low extent* *2 = to a low extent* *3 = to a rather low extent* *4 = to a rather high extent* *5 = to a high extent* *6 = to a very high extent*
Education / general pers. development	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Emotional personality development	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Intellectual personality development	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Students' interests	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Nature / natural phenomena	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Everyday life	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Technology	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Occupation	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Science - biology	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Science - chemistry	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Science - physics	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Science - interdisciplinarity	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Out-of-school learning	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Laboratory - Experimental activity	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Interactive lesson	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Teamwork	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Logic	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Periodic assessment of learning	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*
Rewards for best students	[1] [2] [3] [4] [5] [6]	*[1] [2] [3] [4] [5] [6]*

Figure 1 – An extract of PART I of the questionnaire

Per column you can choose between 1 and 5 categories that you consider especially relevant				
Situations, contexts, motives that can be taken as a basis to stimulate science-related educational processes	IIa:(basic) concepts and topics that should be taught in science lessons	IIb: Scientific fields and perspectives from wich science-related issues can be considered	Qualifications that can be enhanced through engaging in the sciences	Methodical Aspects
□ Education / general pers. development	□ Chemical reactions	□ Botany	□ (Specialized) knowledge	□ Cooperative learning
□ Emotional personality development	□ Energy	□ Human biology	□ Comprehension / understanding	□ Interdisciplinary learning
□ Intellectual personality development	□ Interaction	□ Ecology	□ Applying knowledge / thinking abstractly	□ Inquiry-based science learning
□ Students' interests	□ Development / growth	□ Inorganic chemistry	□ Judgement / opinion-Forming /reflection	□ Role play
□ Nature / natural phenomena	□ Models	□ Organic chemistry	□ Formulating scientific questions/ hypotheses	□ Discussion / debate
□ Everyday life	□ Gas solubility	□ Analytical chemistry	□ Being able to experiment	□ Using new media
□ Technology	□ Terminology	□ Biochemistry	□ Rational thinking / analysing /drawing conclusions	□ Concept maps
□ Occupation	□ Heat and temperature	□ Mechanics	□ Working self-dependently /structuredly / precisely	□ Self-assessment
□ Science - biology	□ Greenhouse effect / transformations	□ Earth sciences	□ Reading comprehension	
□ Science - chemistry	□ Measurement uncertainty	□ Zoology	□ Communication skills	
□ Science - physics	□ Scientific Inquiry	□ Mathematics/physics, chemistry	□ Knowledge about scientific occupations	
□ Science - interdisciplinarity	□ Health / medicine	□ Interdisciplinarity	□ Social skills / teamwork	
□ Out-of-school learning	□ Matter in everyday life	□ Current scientific research	□ Motivation / interest / curiosity	
□ Laboratory - Experimental activity	□ Technical devices	□ Consequences of technol. developm.	□ Critical questioning	
□ Interactive lesson	□ Environment	□ History of the sciences	□ Acting reflectively and responsibly	
□ Teamwork	□ Direct and Inverse proportionality	□ Ethics / values	□ Problem solving	
□ Logic	□ Nutrition education	□ Astronomy / space system	□ Deductive/inductive reasoning	
□ Periodic assessment of learning	□ Probability	□ All science subjects are equally important	□ Determination	
□ Rewards for best students	□ Safety and risks		□ Ability to select data and information	
	□ Occupations / occupational fields			
	□ Living beings / Biological molecules			
	□ Earth and universe			
	□ New technologies			
	□ Main and basic knowledge			

Figure 2 PART II of the questionnaire

4 Sample structure and form of the responses

The questionnaires have been distributed to all those who attended the first round.
As in the first part of the study, our sample is composed of:
- students;
- university students;
- science teacher;
- scientists.

Unfortunately, not all participants contributed as before, and our final sample is now composed of 92 elements, fewer in number than we have obtained in the first round (see Table 2 and Table 3).

Table 2: Comparison between the participants of the first and second round

Sample Structure					
	Students at school	University students	Science teachers	Scientists	Total
Number of participants round 1	44	59	28	42	173
Number of participants round 2	12	34	20	26	92

Table 3: Second round - Participants for each sample subgroup

Group	Subgroup		Number	Total number
Students	Students at school without advanced science courses	Biology		12
		Chemistry		
		Physics		
		Science	0	
	Students at school with advanced sciences courses	Biology		
		Chemistry		
		Physics		
		Science	12	
Teacher Students and trainee teachers ("young teachers")	University students in the education program	Biology		34
		Chemistry	34	
		Physics		
		Science		
	Trainee science teachers	Biology		
		Chemistry		
		Physics		
		Science		
Teachers and trainee teacher educators (experienced teachers)	Science teachers	Biology	1	20
		Chemistry	7	
		Physics	2	
		Mathematics	1	
		Science	9	
	Science trainee teachers educators	Biology		
		Chemistry		
		Physics		
		Science		
Educators, didactics, and in-service teacher educators	Chemistry			
	Physics			
	Biology			
	General Science/Primary Science			
Scientists	Chemists		1	26
	Biologists		3	
	Physicists		3	
	Others		19	

5 Results of the descriptive analyses

5.1 Priority assessment

Referring to the priority assessment, in the Table 4 the top 10 and the low 10 categories identified by the total sample are listed. As you can see, the absolute priority is given to two categories: "Comprehension/understanding" and "Reading comprehension" (for both the mean value is = 5.5); while the two categories for which the mean value is particularly low are "zoology" and "botany". Anyway, in general the categories related to the qualifications as "motivation", "reflection", "rational thinking" are very important.

Among the top 10 there is also the problem solving. This is a methodical aspect very important for many subjects.

Table 4: Priority assessment - Top ten and low ten categories identified by the total sample

Category	Mean Value
Comprehension / understanding	5.5
Reading comprehension	5.5
Motivation / interest / curiosity	5.4
Judgement / opinion-Forming /reflection	5.4
Using new media	5.4
Rational thinking / analysing /drawing conclusions	5.4
Mathematics/physics, chemistry	5.3
(Specialized) knowledge	5.2
Problem solving	5.2
Working self-dependently /structuredly / precisely	5.1
…	
Emotional personality development	4.1
Mechanics	4.1
Biochemistry	4.0
Probability	4.0
History of the sciences	3.9
Analytical chemistry	3.7
Astronomy / space system	3.7
Gas solubility	3.6
Zoology	3.4
Botany	3.1

In the following tables (Tab. 5 – Tab. 9) all the mean values related to the priority assessment of the different sample subgroup and of the total sample are listed.

Referring to the "situation, contexts, motives" (Table 5) the "Occupation" is very important both for Students at school and University Students (the mean value is respectively equal to 5.5 and 5.2), for the University Student also the "Student's interest" (Mean Value = 5.2) should be taken as a basis to stimulate science-related educational processes. For the subgroup of Science teacher the category with the highest mean value (equal to 5.5) is "Laboratory-Experimental activity". For the Scientists the highest values (equal to 5.0) are those related to 4 categories: "Intellectual personality development", "Science – interdisciplinarity", "Laboratory - Experimental activity" and "Periodic assessment of learning". With reference to the total sample the "Laboratory-Experimental activity" has the highest priority (mean value of the total sample = 5.1).

The major differences between the views of students and teachers were found with regard to the "(basic) concepts and topics" and the "Scientific fields and perspectives" (Table 6 and 7). For example, for the students the main aspects are those related to the occupation or technical devices, while for the teacher very important are the matter in everyday life and the environment. Anyway, for all the subgroup the main values related to Mathematics/physics, chemistry are very high (greater than 5).

With reference to the "qualifications" (Table 8) most of the categories is considered very important by all subgroups, especially the "Reading comprehension", the "Comprehension / understanding", the "Rational thinking / analysing /drawing conclusions" and "Motivation / interest / curiosity". For these four categories the mean values are greater than 5 and in the case of sub-group of science teachers are even equal to 5.7 and 5.8.

In the Table 9 the results show that according to the opinion of the science teacher and the scientists the methodical aspects retained more effective are mainly "Interdisciplinary learning", the "Inquiry-based science learning", the "Discussion/debate" and the "Using of new media", these latter two categories are the most important also for the university student. For students at school have priority the use of new media and the self-assessment.

Table 5: Priority assessment – Mean values related to Situations, Contexts and motives

Situations, contexts, motives that can be taken as a basis to stimulate science-related educational processes	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Education / general pers. development	4.9	4.7	4.4	4.2	4.5
Emotional personality development	3.9	4.2	4.2	4.0	4.1
Intellectual personality development	4.8	5.1	5.0	5.0	5.0
Students' interests	4.8	5.2	4.8	4.7	4.9
Nature / natural phenomena	4.3	4.3	5.2	4.8	4.6
Everyday life	4.3	4.6	5.2	4.7	4.7
Technology	5.1	4.9	4.3	4.4	4.7
Occupation	5.5	5.2	4.2	4.2	4.8
Science - biology	4.1	4.4	4.6	4.4	4.4
Science - chemistry	4.4	4.6	4.8	4.6	4.6
Science - physics	4.4	4.6	4.9	4.8	4.7
Science - interdisciplinarity	4.2	4.6	5.3	5.0	4.8
Out-of-school learning	4.1	4.6	4.5	4.3	4.4
Laboratory - Experimental activity	4.8	5.1	5.5	5.0	5.1
Interactive lesson	4.4	4.5	5.2	4.7	4.7
Teamwork	4.3	4.5	5.3	4.5	4.6
Logic	3.9	4.8	4.9	4.7	4.7
Periodic assessment of learning	4.6	4.9	4.9	5.0	4.9
Rewards for best students	4.8	4.6	4.4	4.7	4.6

Table 6: Priority assessment – Mean values related to (basic) concepts and topics

IIa:(basic) concepts and topics that should be taught in science lessons	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Chemical reactions	4.3	4.3	4.5	3.8	4.2
Energy	4.6	4.6	5.1	4.6	4.7
Interaction	4.5	4.7	5.1	4.7	4.8
Development / growth	4.7	5.1	4.8	4.4	4.8
Models	3.8	4.0	4.7	4.3	4.2
Gas solubility	3.6	3.7	3.5	3.7	3.6
Terminology	4.4	4.4	4.3	4.5	4.4
Heat and temperature	4.4	4.5	4.7	4.5	4.5
Greenhouse effect / transformations	4.8	5.0	4.6	3.7	4.7
Measurement uncertainty	3.8	4.1	4.3	4.9	4.2
Scientific Inquiry	4.8	5.5	4.6	5.0	5.1
Health / medicine	4.6	5.1	4.7	4.3	4.7
Matter in everyday life	4.8	5.0	5.4	4.9	5.0
Technical devices	5.1	5.0	4.4	4.7	4.8
Environment	4.9	5.2	5.3	5.0	5.1
Direct and Inverse proportionality	3.8	4.2	4.6	4.2	4.2
Nutrition education	4.0	4.8	5.0	4.2	4.7
Probability	4.2	3.8	4.4	3.9	4.0
Safety and risks	4.5	4.8	4.8	4.5	4.7
Occupations / occupational fields	5.0	5.4	4.3	4.0	4.7
Living beings / Biological molecules	4.0	4.4	4.6	4.2	4.3
Earth and universe	4.3	4.5	4.4	4.2	4.4
New technologies	4.9	5.2	4.4	4.5	4.8
Main and basic knowledge	5.0	5.1	5.3	4.6	5.0

Table 7: Priority assessment – Mean values related to scientific fields and perspectives

IIb: Scientific fields and perspectives from which science-related issues can be considered	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Botany	3.1	3.1	3.2	3.2	3.1
Human biology	4.6	4.4	4.1	4.1	4.3
Ecology	4.3	4.5	4.7	4.2	4.4
Inorganic chemistry	4.3	4.2	4.3	3.8	4.1
Organic chemistry	4.4	4.3	4.3	3.8	4.2
Analytical chemistry	4.3	4.1	3.6	3.1	3.7
Biochemistry	4.0	4.2	4.3	3.6	4.0
Mechanics	4.3	4.4	3.9	3.7	4.1
Earth sciences	4.3	4.1	4.2	4.0	4.1
Zoology	3.8	3.4	3.4	3.3	3.4
Mathematics/physics, chemistry	5.5	5.3	5.4	5.3	5.3
Interdisciplinarity	4.6	5.0	5.4	4.7	5.0
Current scientific research	5.0	5.4	4.6	4.3	4.8
Consequences of technol. developm.	4.8	5.2	5.0	4.7	4.9
History of the sciences	3.8	3.7	4.4	3.9	3.9
Ethics / values	4.8	5.3	4.9	4.5	4.9
Astronomy / space system	3.5	3.7	4.1	3.4	3.7
All science subjects are equally important	3.9	4.4	4.5	3.9	4.2

Table 8: Priority assessment – Mean values related to qualifications

Qualifications that can be enhanced through engaging in the sciences	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
(Specialized) knowledge	5.0	5.0	5.6	5.2	5.2
Comprehension / understanding	5.1	5.5	5.8	5.4	5.5
Applying knowledge / thinking abstractly	4.9	5.1	4.8	4.6	4.9
Judgement / opinion-Forming /reflection	5.1	5.4	5.8	5.2	5.4
Formulating scientific questions/ hypotheses	4.4	5.3	5.1	4.8	5.0
Being able to experiment	4.7	5.0	4.7	4.4	4.7
Rational thinking / analysing /drawing conclusions	5.1	5.5	5.7	5.1	5.4
Working self-dependently /structuredly / precisely	5.3	5.4	5.2	4.7	5.1
Reading comprehension	5.3	5.3	5.9	5.4	5.5
Communication skills	5.2	5.2	5.0	4.7	5.0
Knowledge about scientific occupations	4.5	5.0	4.7	4.4	4.7
Social skills / teamwork	4.9	5.2	5.5	4.8	5.1
Motivation / interest / curiosity	5.3	5.5	5.7	5.2	5.4
Critical questioning	4.8	5.0	5.3	5.0	5.0
Acting reflectively and responsibly	4.8	5.3	5.2	4.8	5.1
Problem solving	5.0	5.4	5.3	4.8	5.2
Deductive/inductive reasoning	4.8	5.0	5.0	5.0	5.0
Determination	5.4	5.4	4.9	4.8	5.1
Ability to select data and information	5.0	5.1	5.2	4.0	5.0

Table 9: Priority assessment – Mean values related to the methodical aspects

Methodical Aspects	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Cooperative learning	4.4	4.8	5.2	4.3	4.7
Interdisciplinary learning	4.5	4.8	5.3	4.7	4.8
Inquiry-based science learning	4.5	4.7	5.3	4.7	4.8
Role play	4.2	4.3	5.0	4.2	4.4
Discussion / debate	4.4	5.0	5.1	4.5	4.8
Using new media	4.6	5.1	5.0	4.5	4.8
Concept maps	4.4	4.8	5.2	4.3	4.7
Self-assessment	4.6	4.5	5.1	4.3	4.6

5.2 Practice assessment

Referring to the practice assessment the mean values are generally lower than those found with reference to the priority. In the Table 10 the top ten and the low ten categories of the total sample are listed. In the opinion of our participants, the periodic assessment of learning is widely used in science education. Furthermore the laboratory and experimental activities are not very practiced, while being very important (§ 5.1).

The Tables 11-15 provide all the mean values obtained with reference to the different sample subgroups and to the total sample. The most important aspects are those related to the tables of qualifications and methodical aspects (Table 14 and 15), it can be noted that the mean values are generally low, especially compared to the priority that our participants gave to these categories. This can be seen even better in the following paragraph which shows the comparisons between priority and practice assessment.

Table 10: Top ten and low ten categories identified by the total sample

Category	Mean Value
Periodic assessment of learning	4.0
Mathematics/physics, chemistry	3.9
(Specialized) knowledge	3.7
Main and basic knowledge	3.6
Reading comprehension	3.6
Earth and universe	3.6
Heat and temperature	3.5
Science - physics	3.4
Science - biology	3.4
Communication skills	3.3
…	
Role play	2.5
Education / general pers. development	2.5
Probability	2.4
Logic	2.4
Laboratory - Experimental activity	2.4
Biochemistry	2.4
History of the sciences	2.3
Zoology	2.3
Current scientific research	2.2
Botany	2.2

Table 11: Practice assessment – Mean values related to Situations, Contexts and motives

Situations, contexts, motives that can be taken as a basis to stimulate science-related educational processes	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Education / general pers. development	3.3	2.7	2.3	2.6	2.5
Emotional personality development	2.9	2.7	2.4	2.6	2.6
Intellectual personality development	3.5	3.3	3.0	3.0	3.1
Students' interests	3.4	2.9	2.7	2.6	2.8
Nature / natural phenomena	3.5	3.1	3.7	3.0	3.2
Everyday life	3.3	3.2	3.2	2.8	3.0
Technology	3.7	3.2	3.2	2.8	3.1
Occupation	3.2	2.5	2.6	2.3	2.5
Science - biology	3.5	3.4	3.6	3.2	3.4
Science - chemistry	3.8	3.6	3.1	2.9	3.3
Science - physics	3.7	3.5	3.7	3.0	3.4
Science - interdisciplinarity	3.2	2.9	2.4	2.5	2.7
Out-of-school learning	2.9	2.7	2.4	2.4	2.6
Laboratory - Experimental activity	2.8	2.3	2.6	2.3	2.4
Interactive lesson	2.8	2.5	2.7	2.3	2.5
Teamwork	3.3	2.8	2.5	3.0	2.8
Logic	2.9	2.2	2.6	2.5	2.4
Periodic assessment of learning	3.9	4.0	4.4	3.7	4.0
Rewards for best students	3.0	2.9	2.7	2.2	2.6

Table 12: Practice assessment – Mean values related to (basic) concepts and topics

IIa:(basic) concepts and topics that should be taught in science lessons	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Chemical reactions	3.7	3.4	3.3	2.6	3.2
Energy	3.2	3.3	3.4	2.5	3.0
Interaction	3.5	2.9	2.5	2.4	2.7
Development / growth	3.7	2.8	2.7	2.5	2.8
Models	3.6	3.0	2.5	2.4	2.8
Gas solubility	3.3	2.8	2.2	3.2	2.8
Terminology	4.2	3.4	3.3	2.6	3.3
Heat and temperature	3.7	3.5	3.5	3.0	3.5
Greenhouse effect / transformations	3.4	3.1	3.3	2.8	3.2
Measurement uncertainty	3.3	3.1	2.6	2.2	2.9
Scientific Inquiry	3.6	2.6	2.4	2.5	2.7
Health / medicine	3.3	2.8	2.9	2.6	2.8
Matter in everyday life	3.5	2.9	3.1	2.7	3.0
Technical devices	3.8	2.8	3.2	3.0	3.1
Environment	3.6	2.9	3.5	3.2	3.2
Direct and Inverse proportionality	3.3	3.2	3.4	3.0	3.3
Nutrition education	2.8	2.5	3.1	2.8	2.7
Probability	2.7	2.7	1.9	2.2	2.4
Safety and risks	3.3	2.7	2.8	2.5	2.8
Occupations / occupational fields	3.2	2.5	2.9	2.5	2.7
Living beings / Biological molecules	3.6	3.2	3.5	2.8	3.3
Earth and universe	3.5	3.5	3.8	3.2	3.6
New technologies	3.2	2.6	2.7	2.5	2.7
Main and basic knowledge	4.0	3.5	3.3	3.6	3.6

Table 13: Practice assessment – Mean values related to scientific fields and perspectives

IIb: Scientific fields and perspectives from which science-related issues can be considered	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Botany	1.8	1.9	2.3	2.6	2.2
Human biology	3.3	3.2	3.4	3.1	3.2
Ecology	2.8	2.4	2.7	2.9	2.7
Inorganic chemistry	3.6	3.1	2.9	3.1	3.1
Organic chemistry	3.8	3.0	2.5	2.5	2.8
Analytical chemistry	3.5	2.6	2.7	2.3	2.7
Biochemistry	2.8	2.3	2.7	2.1	2.4
Mechanics	3.1	2.8	2.8	2.9	2.8
Earth sciences	3.8	3.3	3.4	2.8	3.2
Zoology	2.3	2.0	2.4	2.5	2.3
Mathematics/physics, chemistry	4.7	4.0	3.4	3.9	3.9
Interdisciplinarity	3.3	3.1	2.0	2.6	2.8
Current scientific research	2.3	2.3	2.0	2.2	2.2
Consequences of technol. developm.	3.3	2.5	2.4	2.5	2.6
History of the sciences	2.6	2.7	1.9	2.1	2.3
Ethics / values	3.1	2.4	1.9	2.6	2.5
Astronomy / space system	3.0	2.8	2.7	2.8	2.8
All science subjects are equally important	3.3	3.1	2.7	3.1	3.1

Table 14: Practice assessment – Mean values related to the qualifications

Qualifications that can be enhanced through engaging in the sciences	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
(Specialized) knowledge	3.9	3.7	3.7	3.5	3.7
Comprehension / understanding	3.8	3.2	2.9	3.2	3.2
Applying knowledge / thinking abstractly	3.8	3.4	3.3	3.1	3.3
Judgement / opinion-Forming /reflection	3.8	2.9	3.1	2.8	3.0
Formulating scientific questions/ hypotheses	3.4	2.7	2.2	2.5	2.6
Being able to experiment	3.3	2.5	2.2	2.5	2.5
Rational thinking / analysing /drawing conclusions	3.5	3.1	2.9	2.7	3.0
Working self-dependently /structuredly / precisely	3.3	3.1	2.9	2.6	2.9
Reading comprehension	3.8	3.7	3.6	3.2	3.6
Communication skills	3.5	3.6	3.2	3.0	3.3
Knowledge about scientific occupations	2.8	3.0	2.6	2.8	2.8
Social skills / teamwork	3.6	3.1	2.6	2.9	3.0
Motivation / interest / curiosity	3.4	2.6	2.9	3.0	2.9
Critical questioning	3.7	2.8	2.8	2.6	2.9
Acting reflectively and responsibly	3.4	3.1	3.1	2.7	3.0
Problem solving	3.3	2.8	2.5	2.6	2.7
Deductive/inductive reasoning	3.6	3.0	3.0	2.9	3.1
Determination	3.4	2.9	3.3	2.8	3.0
Ability to select data and information	3.6	3.4	2.9	2.6	3.3

Table 15: Practice assessment – Mean values related to the methodical aspects

Methodical Aspects	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Cooperative learning	3.6	2.8	2.5	2.7	2.8
Interdisciplinary learning	3.7	2.8	2.3	2.4	2.7
Inquiry-based science learning	3.8	2.8	2.3	2.7	2.8
Role play	3.6	2.1	2.0	2.7	2.5
Discussion / debate	3.2	2.6	2.8	2.7	2.7
Using new media	3.2	2.3	2.4	2.7	2.5
Concept maps	3.8	3.4	2.6	2.9	3.1
Self-assessment	3.3	3.0	2.2	2.4	2.7

5.3 Priority-Practice differences

The Table 16 shows the top ten and the low ten mean values regarding the Priority-Practice differences of the total sample. In the Figures 3-7, for each category system of this study, it is possible to make a direct comparison between the assessment of priority and practice that the total sample gave for all categories. As we can see, the main differences are mainly in the following aspects:

- situation, contexts and motives: “Laboratory-experimental activity”;
- (basic) concepts and topics: “scientific inquiry”;
- scientific fields: “current scientific research”;
- qualifications: “motivation, interest, curiosity”;
- methodical aspects: “using new media”.

In the Tables 17-21 are listed the mean values of the priority-practice differences divided according of our four sample subgroups. Compared to the results obtained for the total sample, we observe that in the opinion of the students at school and university students there is a large gap between priority and practice also for the category “occupation”, while for science teachers and scientists there is a big gap in “science-interdisciplinarity” (see Table 17).

With reference to methodological aspects (Table 21) a remarkable result is that the science teachers believe that the difference between priority and practice is greater in the category "self-assessment" rather than in “using new media”, while for the scientists the largest gap occurs in the category “interdisciplinary learning”.

Table 16: Top ten and low ten categories identified by the total sample

Category	Mean Value
Using new media	2.8
Laboratory - Experimental activity	2.7
Current scientific research	2.6
Motivation / interest / curiosity	2.5
Ethics / values	2.4
Problem solving	2.4
Scientific Inquiry	2.4
Rational thinking / analysing /drawing conclusions	2.4
Judgement / opinion-Forming /reflection	2.4
Consequences of technol. developm.	2.4
…	
Living beings / Biological molecules	1.0
Inorganic chemistry	1.0
Human biology	1.0
Botany	0.9
Direct and Inverse proportionality	0.9
Periodic assessment of learning	0.9
Earth and universe	0.9
Astronomy / space system	0.9
Earth sciences	0.9
Gas solubility	0.8

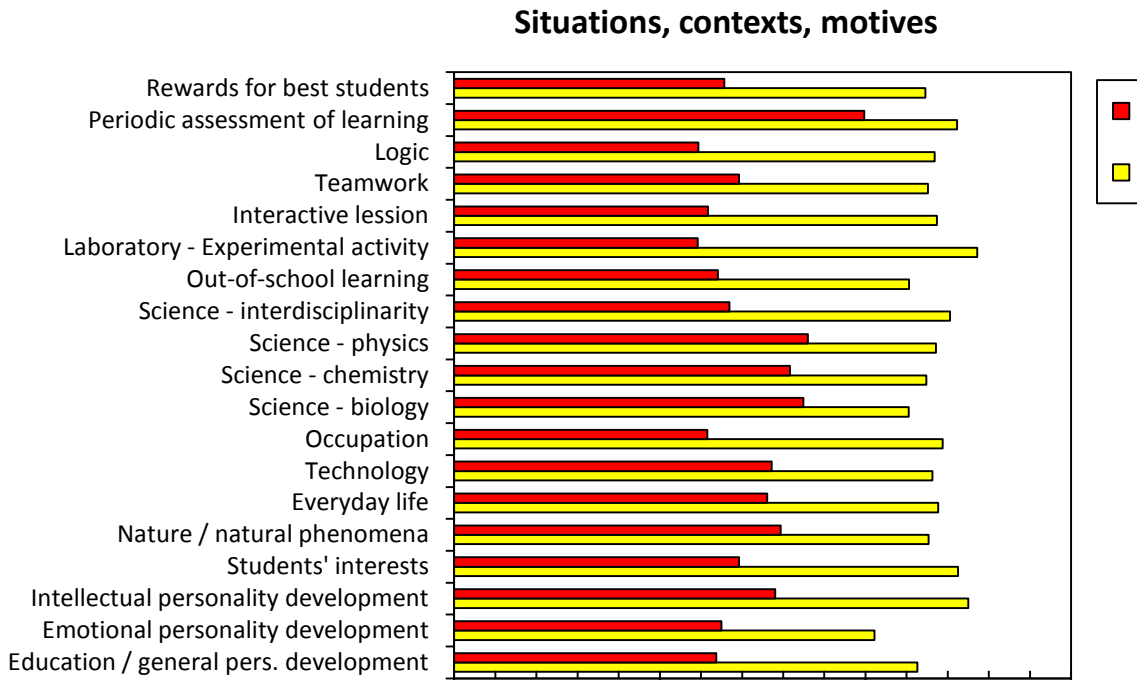

Figure 3: Situation, contexts, motives - Comparison between the priority and practice assessment of the total sample

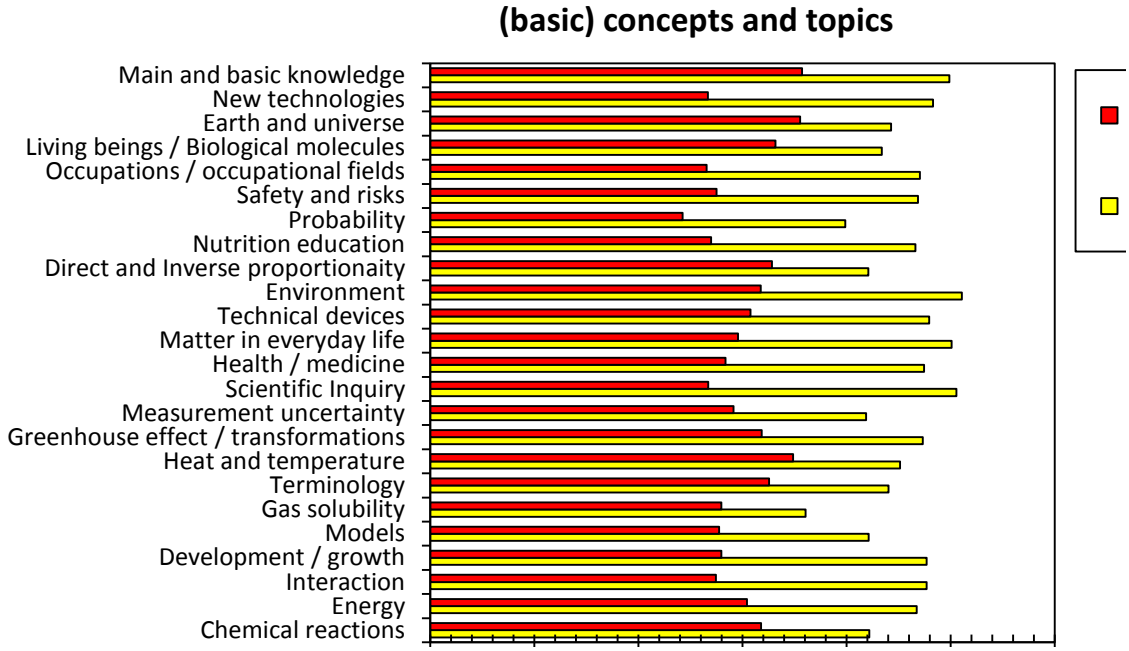

Figure 4: (basic) concepts and topics - Comparison between the priority and practice assessment of the total sample

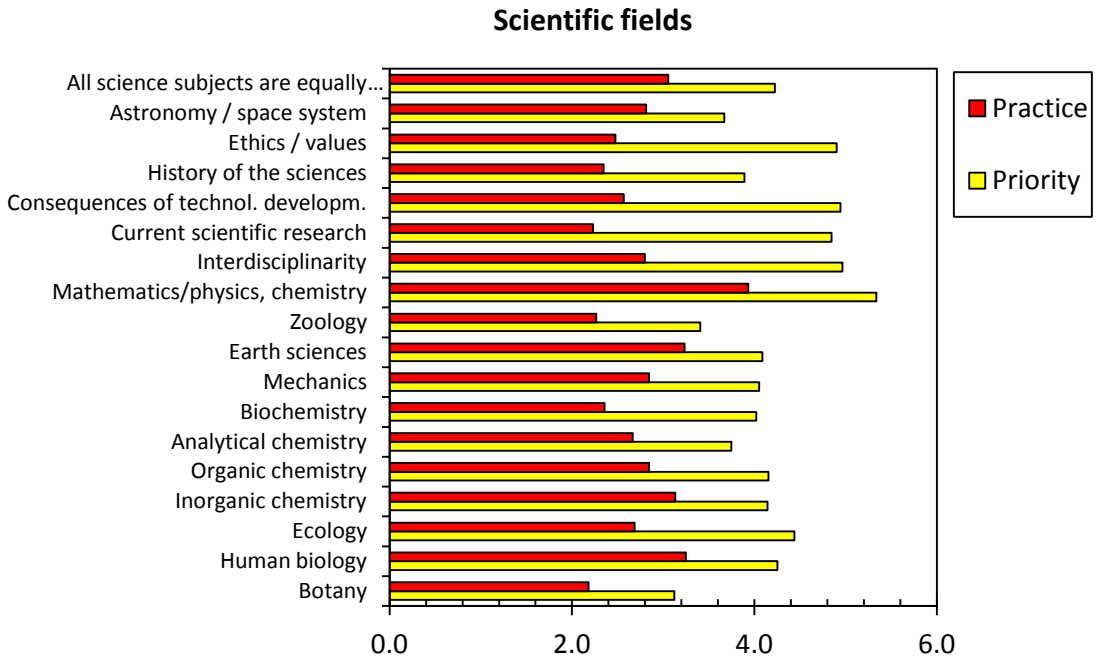

Figure 5: Scientific fields - Comparison between the priority and practice assessment of the total sample

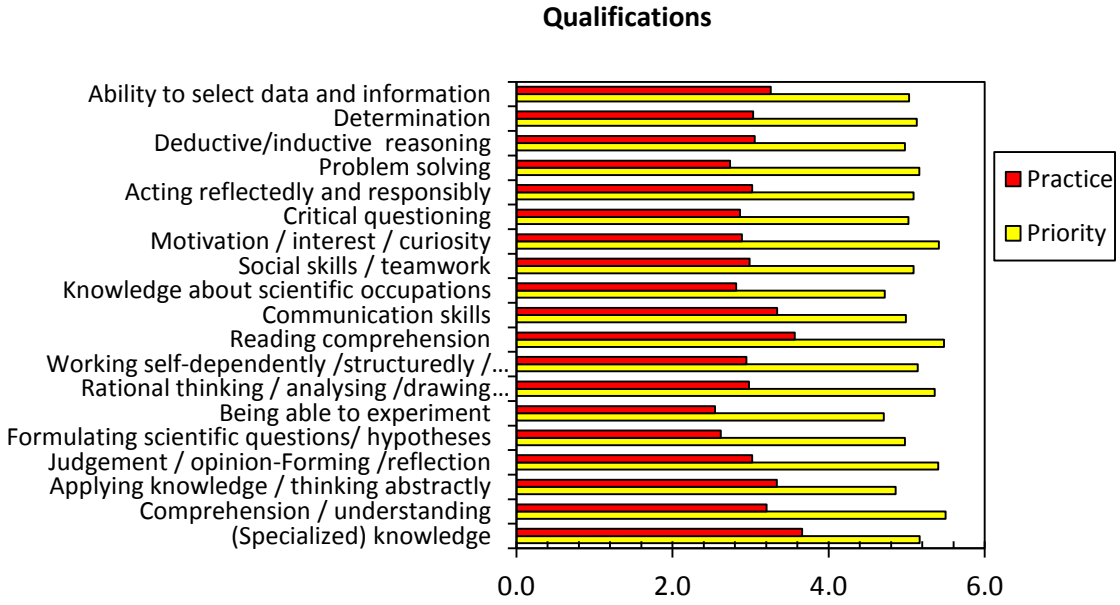

Figure 6: Qualifications - Comparison between the priority and practice assessment of the total sample

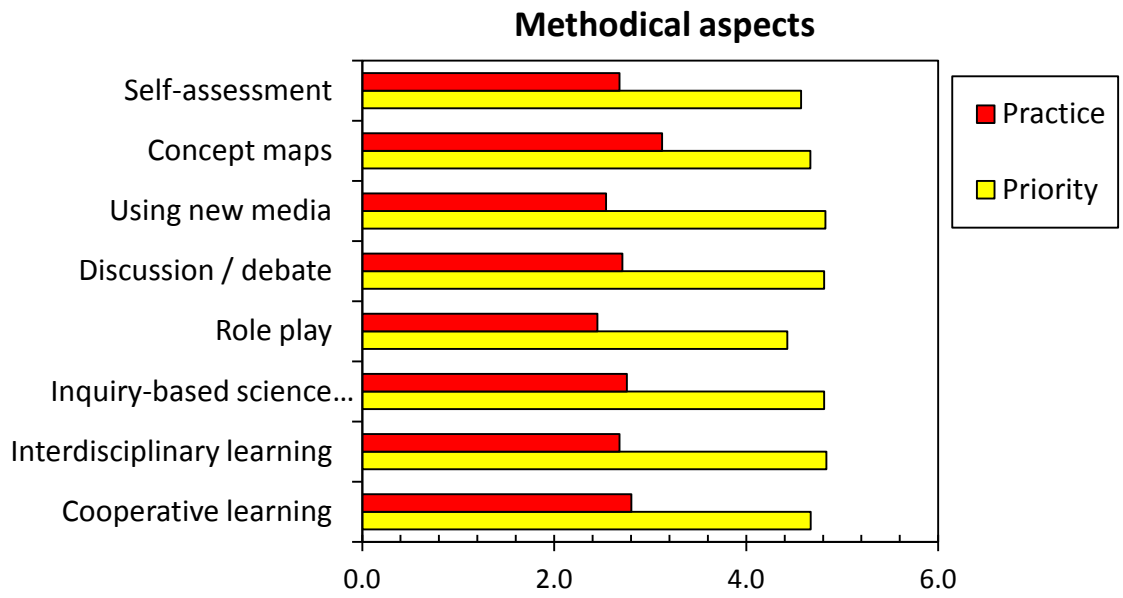

Figure 7: Methodical aspects - Comparison between the priority and practice assessment of the total sample

Table 17: Mean values of the Priority-Practice differences related to „Situations, Contexts and motives“

Situations, contexts, motives that can be taken as a basis to stimulate science-related educational processes	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Education / general pers. development	1.6	2.0	2.1	1.7	2.0
Emotional personality development	1.0	1.5	1.8	1.4	1.5
Intellectual personality development	1.3	1.9	2.0	2.0	1.9
Students' interests	1.4	2.2	2.1	2.1	2.1
Nature / natural phenomena	0.8	1.2	1.5	1.8	1.4
Everyday life	1.1	1.4	2.1	1.9	1.7
Technology	1.4	1.7	1.2	1.6	1.6
Occupation	2.3	2.7	1.6	2.0	2.3
Science - biology	0.6	1.0	1.1	1.2	1.0
Science - chemistry	0.7	1.0	1.7	1.7	1.3
Science - physics	0.8	1.0	1.2	1.7	1.2
Science - interdisciplinarity	1.0	1.7	2.9	2.5	2.1
Out-of-school learning	1.2	1.8	2.1	2.0	1.9
Laboratory - Experimental activity	2.1	2.7	2.9	2.7	2.7
Interactive lesson	1.6	2.0	2.6	2.4	2.2
Teamwork	0.9	1.7	2.8	1.4	1.8
Logic	1.0	2.6	2.3	2.2	2.3
Periodic assessment of learning	0.7	0.9	0.5	1.3	0.9
Rewards for best students	1.8	1.7	1.7	2.6	2.0

Table 18: Mean values of the Priority-Practice differences related to (basic) concepts and topics

IIa:(basic) concepts and topics that should be taught in science lessons	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Chemical reactions	0.7	0.9	1.2	1.3	1.0
Energy	1.4	1.3	1.7	2.1	1.6
Interaction	1.0	1.8	2.6	2.4	2.0
Development / growth	1.0	2.3	2.1	1.9	2.0
Models	0.3	1.1	2.2	1.9	1.4
Gas solubility	0.3	0.9	1.3	0.5	0.8
Terminology	0.3	1.0	1.0	1.9	1.1
Heat and temperature	0.8	1.0	1.2	1.5	1.0
Greenhouse effect / transformations	1.4	1.8	1.3	0.8	1.5
Measurement uncertainty	0.5	1.0	1.7	2.7	1.3
Scientific Inquiry	1.3	2.8	2.2	2.5	2.4
Health / medicine	1.3	2.3	1.9	1.7	1.9
Matter in everyday life	1.3	2.1	2.3	2.2	2.1
Technical devices	1.3	2.2	1.3	1.6	1.7
Environment	1.3	2.3	1.8	1.8	1.9
Direct and Inverse proportionality	0.5	0.9	1.2	1.2	0.9
Nutrition education	1.2	2.4	1.9	1.4	2.0
Probability	1.5	1.1	2.4	1.6	1.6
Safety and risks	1.3	2.1	2.1	2.0	1.9
Occupations / occupational fields	1.8	2.9	1.4	1.5	2.0
Living beings / Biological molecules	0.4	1.1	1.2	1.4	1.0
Earth and universe	0.8	1.0	0.6	1.0	0.9
New technologies	1.8	2.6	1.7	2.0	2.2
Main and basic knowledge	1.0	1.6	2.0	1.0	1.4

Table 19: Mean values of the Priority-Practice differences related to scientific fields and perspectives

IIb: Scientific fields and perspectives from which science-related issues can be considered	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Botany	1.3	1.1	0.9	0.6	0.9
Human biology	1.3	1.1	0.7	0.9	1.0
Ecology	1.6	2.0	2.0	1.3	1.8
Inorganic chemistry	0.8	1.1	1.4	0.7	1.0
Organic chemistry	0.7	1.3	1.8	1.3	1.3
Analytical chemistry	0.8	1.5	0.8	0.7	1.1

Biochemistry	1.3	1.9	1.6	1.5	1.7
Mechanics	1.2	1.7	1.1	0.8	1.2
Earth sciences	0.6	0.7	0.8	1.1	0.9
Zoology	1.6	1.3	1.0	0.8	1.1
Mathematics/physics, chemistry	0.8	1.4	2.0	1.4	1.4
Interdisciplinarity	1.3	1.9	3.4	2.1	2.2
Current scientific research	2.7	3.0	2.6	2.1	2.6
Consequences of technol. developm.	1.4	2.7	2.6	2.3	2.4
History of the sciences	1.2	1.0	2.4	1.8	1.5
Ethics / values	1.7	2.9	2.9	1.9	2.4
Astronomy / space system	0.5	0.9	1.3	0.6	0.9
All science subjects are equally important	0.7	1.4	1.8	0.7	1.2

Table 20: Mean values of the Priority-Practice differences related to the qualifications

Qualifications that can be enhanced through engaging in the sciences	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
(Specialized) knowledge	1.1	1.3	1.9	1.7	1.5
Comprehension / understanding	1.3	2.3	2.9	2.3	2.3
Applying knowledge / thinking abstractly	1.1	1.7	1.6	1.5	1.5
Judgement / opinion-Forming /reflection	1.3	2.6	2.7	2.4	2.4
Formulating scientific questions/ hypotheses	1.0	2.6	2.9	2.3	2.4
Being able to experiment	1.3	2.5	2.5	1.9	2.2
Rational thinking / analysing /drawing conclusions	1.6	2.4	2.8	2.4	2.4
Working self-dependently /structuredly / precisely	2.0	2.3	2.3	2.1	2.2
Reading comprehension	1.6	1.6	2.3	2.2	1.9
Communication skills	1.7	1.6	1.8	1.7	1.6
Knowledge about scientific occupations	1.7	2.1	2.2	1.6	1.9
Social skills / teamwork	1.3	2.1	2.9	1.9	2.1
Motivation / interest / curiosity	1.8	2.9	2.8	2.2	2.5
Critical questioning	1.1	2.2	2.5	2.3	2.2
Acting reflectively and responsibly	1.4	2.2	2.2	2.2	2.1
Problem solving	1.7	2.6	2.8	2.2	2.4
Deductive/inductive reasoning	1.3	2.0	2.1	2.0	1.9
Determination	2.0	2.4	1.7	2.0	2.1
Ability to select data and information	1.4	1.7	2.3	1.4	1.8

Table 21: Mean values of the Priority-Practice differences related to the methodical aspects

Methodical Aspects	Mean Values				
	Students at school	University students	Science teachers	Scientists	Total
Cooperative learning	0.8	1.9	2.8	1.6	1.9
Interdisciplinary learning	0.8	2.0	3.0	2.3	2.2
Inquiry-based science learning	0.7	2.0	3.0	2.1	2.1
Role play	0.6	2.2	3.0	1.5	2.0
Discussion / debate	1.3	2.5	2.3	1.9	2.1
Using new media	1.4	2.8	2.6	1.8	2.3
Concept maps	0.6	1.4	2.6	1.4	1.5
Self-assessment	1.3	1.5	2.9	1.9	1.9

6 Results of the cluster analyses

With regard to the second part of the questionnaire a hierarchical cluster analysis was performed.

In the following paragraphs, the clusters identified from the data analysis and the frequency of the categories within the different clusters are presented.

6.1 Clustering based on the cases

The dendrogram represented in Figure 8 shows the arrangement of the categories within the clusters. Based on the obtained results, a three clusters solution was identified.

In the Table 22 the categories of each cluster are listed. In the same table the number of categories (ncat), the number of cases (ncases) and the relative frequency regarding all cases (n%cases) are shown in each of three clusters. It can be seen as follow:

- in the cluster A there are 42 categories and 409 cases (equal to 22.7 % of all cases);
- in the cluster B there are 19 categories and 447 cases (equal to 24.9 % of all cases);
- in the cluster C there are 26 categories and 942 cases (equal to 52.4 % of all cases).

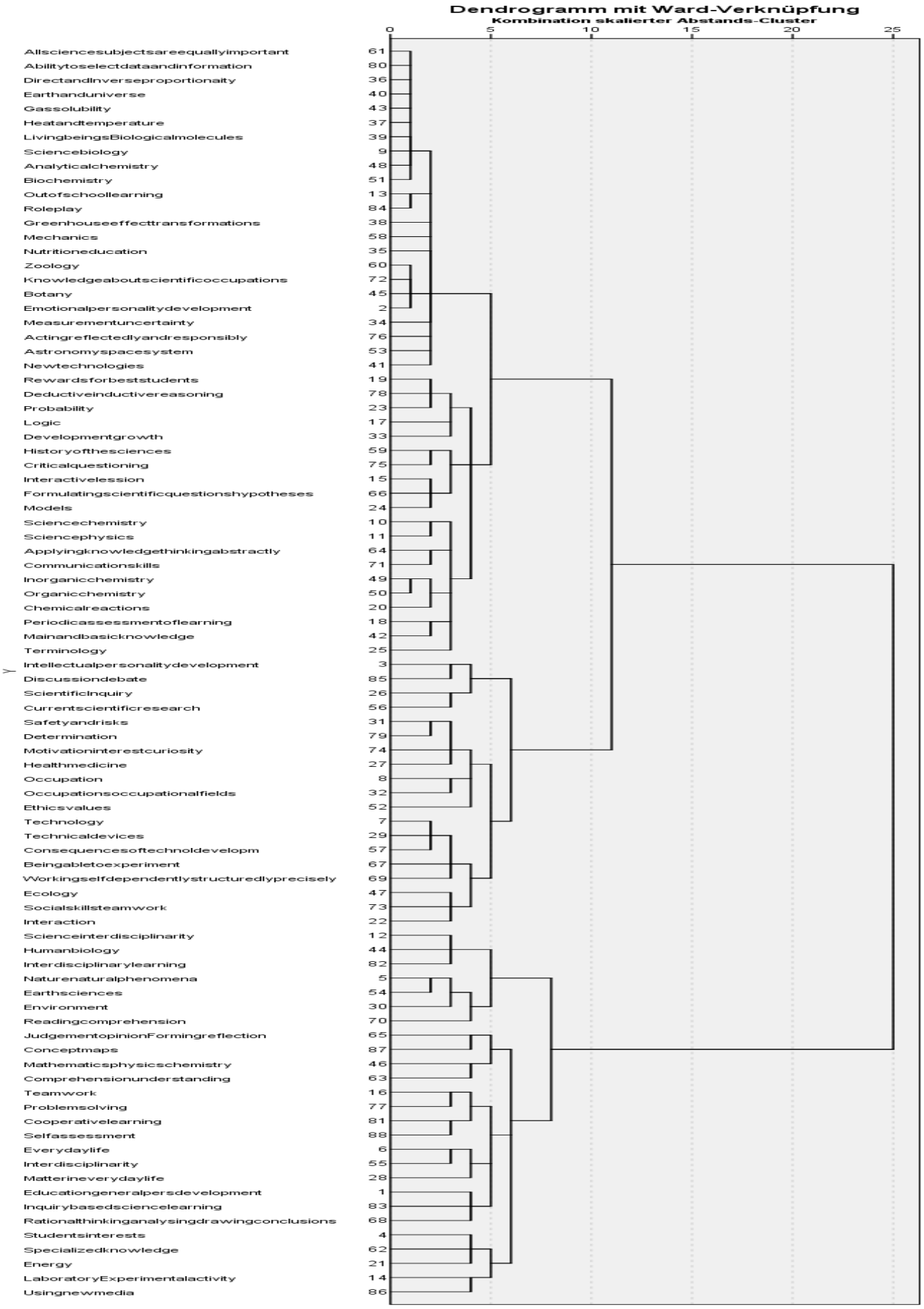

Figure 8: Dendrogram (method: ward linkage and squared Euclidian distance)

Table 22: Distribution of the categories in the three-cluster solution

Cluster A	Cluster B	Cluster C
• Emotional personality development • Science - biology • Science - chemistry • Science - physics • Out-of-school learning • Interactive lession • Logic • Periodic assessment of learning • Rewards for best students • Chemical reactions • Probability • Models • Terminology • Development / growth • Measurement uncertainty • Nutrition education • Direct and Inverse proportionaity • Heat and temperature • Greenhouse effect / transformations • Living beings / Biological molecules • Earth and universe • New technologies • Main and basic knowledge • Gas solubility • Botany • Analytical chemistry • Inorganic chemistry • Organic chemistry • Biochemistry • Astronomy / space system • Mechanics • History of the sciences • Zoology • All science subjects are equally important • Applying knowledge / thinking abstractly • Formulating scientific questions/ hypotheses • Communication skills • Knowledge about scientific occupations • Critical questioning • Acting reflectedly and responsibly • Deductive/inductive reasoning • Ability to select data and information • Role play	• Intellectual personality development • Technology • Occupation • Interaction • Scientific Inquiry • Health / medicine • Technical devices • Safety and risks • Occupations / occupational fields • Ecology • Ethics / values • Current scientific research • Consequences of technol. developm. • Being able to experiment • Working self-dependently /structuredly / precisely • Social skills / teamwork • Motivation / interest / curiosity • Determination • Discussion / debate	• Education / general pers. development • Students' interests • Nature / natural phenomena • Everyday life • Science - interdisciplinarity • Laboratory - Experimental activity • Teamwork • Energy • Matter in everyday life • Environment • Human biology • Mathematics/physics, chemistry • Earth sciences • Interdisciplinarity • (Specialized) knowledge • Comprehension / understanding • Judgement / opinion-Forming /reflection • Rational thinking / analysing /drawing conclusions • Reading comprehension • Problem solving • Cooperative learning • Interdisciplinary learning • Inquiry-based science learning • Using new media • Concept maps • Self-assessment
n_{cat} = 43 **n_{cases} = 425** **$n\%_{cases}$ = 23.4**	**n_{cat} = 19** **n_{cases} = 447** **$n\%_{cases}$ =24.6**	**n_{cat} = 26** **n_{cases} = 942** **$n\%_{cases}$ = 52**

6.2 Frequency of the categories in the different clusters

In the Table 23 all the categories are listed. The categories are associated with the cluster to which they belongs. The table also shows the absolute frequency of each category (n), as well as the relative frequency in relation both to the respective cluster (C %) and to all categories (∑%).

In the cluster A and B the categories with the highest values of C % and ∑ % are respectively "Main and basic knowledge" and "Scientific Inquiry", while for the cluster C the main category is "Mathematics/physics, chemistry".

Table 23: Absolute frequency and relative frequencies of the categories

Frequencies / Category	Cluster A			Cluster B			Cluster C		
	n	C%	∑%	n	C%	∑%	n	C%	∑%
Education / general pers. development							30	3.2	1.7
Emotional personality development	7	1.7	0.4						
Intellectual personality development				27	6.0	1.5			
Students' interests							37	3.9	2.1
Nature / natural phenomena							22	2.3	1.2
Everyday life							29	3.1	1.6
Technology				20	4.5	1.1			
Occupation				32	7.2	1.8			
Science - biology	2	0.5	0.1						
Science - chemistry	10	2.4	0.6						
Science - physics	17	4.2	0.9						
Science - interdisciplinarity							29	3.1	1.6
Out-of-school learning	6	1.5	0.3						
Laboratory - Experimental activity							45	4.8	2.5
Interactive lession	13	3.2	0.7						
Teamwork							29	3.1	1.6
Logic	17	4.2	0.9						
Periodic assessment of learning	14	3.4	0.8						
Rewards for best students	16	3.8	0.9						
Chemical reactions	15	3.7	0.8						
Energy							30	3.2	1.7
Interaction				27	6.0	1.5			
Probability	19	4.6	1.1						
Models	19	4.6	1.1						
Terminology	19	4.6	1.1						
Scientific Inquiry				37	8.3	2.1			
Health / medicine				23	5.1	1.3			
Matter in everyday life							40	4.2	2.2
Technical devices				14	3.1	0.8			
Environment							33	3.5	1.8
Safety and risks				16	3.6	0.9			
Occupations / occupational fields				20	4.5	1.1			
Development / growth	24	5.9	1.3						
Measurement uncertainty	8	2.0	0.4						
Nutrition education	10	2.4	0.6						
Direct and Inverse proportionaity	1	0.2	0.1						
Heat and temperature	2	0.5	0.1						
Greenhouse effect / transformations	8	2.0	0.4						

Living beings / Biological molecules	2	0.5	0.1						
Earth and universe	0	0.0	0.0						
New technologies	23	5.6	1.3						
Main and basic knowledge	25	6.1	1.4						
Gas solubility	0	0.0	0.0						
Human biology							22	2.3	1.2
Botany	4	1.0	0.2						
Mathematics/physics, chemistry							73	7.7	4.1
Ecology				19	4.3	1.1			
Analytical chemistry	3	0.7	0.2						
Inorganic chemistry	7	1.7	0.4						
Organic chemistry	6	1.5	0.3						
Biochemistry	4	1.0	0.2						
Ethics / values				27	6.0	1.5			
Astronomy / space system	10	2.4	0.6						
Earth sciences							20	2.1	1.1
Interdisciplinarity							28	3.0	1.6
Current scientific research				33	7.4	1.8			
Consequences of technol. developm.				16	3.6	0.9			
Mechanics	8	2.0	0.4						
History of the sciences	13	3.2	0.7						
Zoology	4	1.0	0.2						
All science subjects are equally important	0	0.0	0.0						
(Specialized) knowledge							45	4.8	2.5
Comprehension / understanding							50	5.3	2.8
Applying knowledge / thinking abstractly	15	3.7	0.8						
Judgement / opinion-Forming /reflection							37	3.9	2.1
Formulating scientific questions/ hypotheses	14	3.4	0.8						
Being able to experiment				15	3.4	0.8			
Rational thinking / analysing /drawing conclusions							38	4.0	2.1
Working self-dependently /structuredly / precisely				19	4.3	1.1			
Reading comprehension							29	3.1	1.6
Communication skills	16	3.9	0.9						
Knowledge about scientific occupations	5	1.2	0.3						
Social skills / teamwork				22	4.9	1.2			
Motivation / interest / curiosity				27	6.0	1.5			
Critical questioning	13	3.2	0.7						
Acting reflectedly and responsibly	8	2.0	0.4						
Problem solving							30	3.2	1.7
Deductive/inductive reasoning	12	2.9	0.7						
Determination				17	3.8	0.9			
Ability to select data and information	0	0.0	0.0						
Cooperative learning							39	4.1	2.2
Interdisciplinary learning							46	4.9	2.6
Inquiry-based science learning							43	4.6	2.4
Role play	6	1.5	0.3						
Discussion / debate				36	8.1	2.0			
Using new media							40	4.2	2.2
Concept maps							46	4.9	2.6
Self-assessment							32	3.4	1.8
Total	425	100.0	23.4	447	100	24.6	942	100	51.9
Total number of all cases	1814								

6.3 Descriptions of the clusters

According to the previous results, different concepts, on which science education should be based, can be associated with clusters. These concepts are defined in the following.

Concept A:

Relevant issues and motivations to improve learning, the interaction among students and communication skills.

Concept A includes most aspects and themes through which student interest is increased. Once the student has acquired the basic knowledge, he should be able to apply the knowledge and he also should be able to formulate critical questioning. Furthermore, interactive lessons and the improvement of communication skills promote the development of emotional personality.

According to the cluster analysis, the following groups of categories are related to the concept A:

Situation, contexts, motives:

Emotional personality development, Science – biology, Science – chemistry, Science – physics, Out-of-school learning, Interactive lesion, Logic, Periodic assessment of learning, Rewards for best student.

(basic) concepts and topics:

Chemical reactions, Probability, Models,Terminology, Development / growth, Measurement uncertainty, Nutrition education, Direct and Inverse proportionality, Heat and temperature, Greenhouse effect / transformations, Living beings / Biological molecules, Earth and universe, New technologies, Main and basic knowledge, Gas solubility.

Scientific fields and perspectives:

Botany, Analytical chemistry, Inorganic chemistry, Organic chemistry, Biochemistry, Astronomy / space system, Mechanics, History of the sciences, Zoology, All science subjects are equally important.

Qualifications:

Applying knowledge / thinking abstractly, Formulating scientific questions/ hypotheses, Communication skills, Knowledge about scientific occupations, Critical questioning, Acting reflectedly and responsibly, Deductive/inductive reasoning, Ability to select data and information.

Methodical Aspects:

Role play.

Concept B:

Intellectual development mainly related to the current scientific research, technical devices, occupation.

Concept B shows the importance of technological development and current scientific research. The motivation and determination play an important role in science education, such as the ability to work and perform experiments self-dependently. Discussions and debates encourage the curiosity and the interest of the students.

According to the cluster analysis, the following groups of categories are related to the concept B:

Situation, contexts, motives:

Intellectual personality development, Technology, Occupation.

(basic) concepts and topics:

Interaction, Scientific Inquiry, Health / medicine, Technical devices, Safety and risks, Occupations / occupational fields

Scientific fields and perspectives:

Ecology, Ethics / values, Current scientific research, Consequences of technol. developm.

Qualifications:

Being able to experiment, Working self-dependently /structuredly / precisely, Social skills / teamwork, Motivation / interest / curiosity, Determination.

Methodical Aspects:

Discussion / debate.

Concept C:

General personality development through innovative methodical aspects which promote the inquiry-based science learning.

The concept refers mainly to the different methodological aspects that can be used to improve the learning of science and inquiry based learning. Using cooperative learning, concept maps or problem solving techniques, personality and reasoning skills of the students are developed, furthermore an interdisciplinary approach is also promoted. The experimental activity, the references to everyday life and the teamwork are very important to increase students' interest in science subjects and to improve their learning. The subjects on which the scientific literacy should be based are mainly mathematics, chemistry and physics.

According to the cluster analysis, the following groups of categories are related to the concept C:

Situation, contexts, motives:

Education / general pers. development, Students' interests, Nature / natural phenomena, Everyday life, Science – interdisciplinarity, Laboratory - Experimental activity,Teamwork.

(basic) concepts and topics:

Energy, Matter in everyday life, Environment.

Scientific fields and perspectives:

Human biology, Mathematics/physics, chemistry, Earth sciences, Interdisciplinarity.

Qualifications:

(Specialized) knowledge, Comprehension / understanding, Judgement / opinion-Forming /reflection, Rational thinking / analysing /drawing conclusions, Reading comprehension, Problem solving.

Methodical Aspects:

Cooperative learning, Interdisciplinary learning, Inquiry-based science learning, Using new media, Concept maps, Self-assessment.

References

Report on the first round of the PROFILES Curricular Delphi study on Science Education, Italy (UNIVPM).