Interim report on the first round of the Delphi study (Portugal / UP)

1 Framework and procedure of the first round – participation rate

1.1 First attempt

In April 2011, 161 'experts' were asked via e-mail to fill out an on-line adaptation of the PROFILES Delphi questionnaire (http://www.emultimedia.com.pt/profiles/) (1st attempt). From these, 22 experts gave their feedback, until the end of July, filling out the on-line form (see Table 1):

Group	Subgroup	Number	Total number
Students	Students at school without advanced science courses	5	6
	Students at school with advanced sciences courses	1	
Teacher Students and trainee teachers ("young teachers")	University students in the education program	7	7
	Trainee science teachers	0	
Teachers and trainee teacher educators (experienced teachers)	Science teachers	3	4
	Science trainee teacher educators	1	
Educators, didactics, and in-service teacher educators		2	2
Scientists		0	0
Education politicians	Spokes persons for education policy	0	0
	Members of the Senate	0	
People who are not directly involved with sciences	University students, Teachers, Parents, Humanists	3	3

Tab. 1: Structure of the sample, amount of participants for each group and participation rate after the first attempt

As explained in the beginning, we sent a request by email to fill up an on-line form, available at http://www.emultimedia.com.pt/profiles/ allowing us to collect the data immediately on a spreadsheet.

In order to assure that each person from the list has received their emails, we have re-sent the email a second time a few weeks later.

Even with this second email, the participation was very low, with some stakeholders replying that the questions were too difficult to understand and also that they didn't understand what was asked.

Due to the Portuguese school organization, it is not possible to distinguish students from their scientific subjects on lower and upper secondary school since students have almost the same disciplines in all different groups. From 7th grade to 9th grade (Students at school without advanced science courses) they have exactly the same subjects, and from 10th grade to 12th grade (Students at school with advanced sciences courses), on their last year, they are able to choose one or two from a set of disciplines. This is also subject to availability on their schools depending on the number of students that sign up for those subjects.

The separation of the "University students in the education program" and "Trainee science teachers" was also impossible, since we have differentiated 3 year base formation (Chemistry, Physics, Math, etc.), but when university students decide to be in the education program, they are placed in a Master degree having almost the same disciplines to all. For example, if a Chemistry student and a Biology student end their 1st three years cycle, and want to be science teachers, they need to have a Master Degree in Education, which is equal to both. Hence, it is difficult to differentiate the subject they most identify themselves at this level.

The difference in the sub-group of "Teachers and trainee teacher educators (experienced teachers)" from their sciences is also difficult in Portugal, since our science teachers are simultaneously Physics and Chemistry teachers, or Biology and Geology teachers, and others. Therefore, we cannot distinguish these teachers as one discipline teachers. Also, the classes that we have are Physics and Chemistry, Biology and Geology, amongst others.

For the same reason we couldn't also distinguish our Educators, didactics, and in-service teacher educators.

Unfortunately we could not have a proper answer from the scientists.

Due to a low response rate we decided to send out questionnaires a second time to more experts. Meanwhile our sample consists of 68 participants/experts (see Tab. 2).

1.2 Second attempt

Group	Subgroup	Number	Total number
Students	Students at school without advanced science courses	8	9
	Students at school with advanced sciences courses	1	
Teacher Students and trainee teachers ("young teachers")	University students in the education program	7	8
	Trainee science teachers	1	
Teachers and trainee teacher educators (experienced teachers)	Science teachers	28	30
	Science trainee teacher educators	2	
Educators, didactics, and in-service teacher educators		2	2
Scientists		0	0
Education politicians	Spokes persons for education policy	0	0
	Members of the Senate	0	
People who are not directly involved with sciences	University students, Teachers, Parents, Humanists	19	19

Tab. 2: Structure of the sample, amount of participants for each group and participation rate after the second attempt

After the 1st attempt we were unable to get the desirable number of answers, so we decided to contact even more potential stakeholders, from their different areas.

In this second attempt we had the precious help of some of the teachers that were on our regular CPD programs. This allowed having some more answers, but unfortunately we could not get any from scientist or from any education politicians.

1.3 Third attempt

Taking advantage of our CPD programs, we were able to get a precious help from two of the teachers that were on them. With their help we carried out a third attempt in February 2012, from where we were able to get the response of more: 11 students, 2 scientists, 2 University students in the education program, 2 Science trainee teacher educators and 1 people who is not directly involved with sciences.

With their help, our sample ended with a total of 86 participants, which distribution can be analyzed in Table 3:

Group	Subgroup	Number	Total number
Students	Students at school without advanced science courses	10	20
	Students at school with advanced sciences courses	10	
Teacher Students and trainee teachers ("young teachers")	University students in the education program	9	10
	Trainee science teachers	1	
Teachers and trainee teacher educators (experienced teachers)	Science teachers	28	32
	Science trainee teacher educators	4	
Educators, didactics, and in-service teacher educators		2	2
Scientists		2	2
Education politicians	Spokes persons for education policy	0	0
	Members of the Senate	0	
People who are not directly involved with sciences	University students, Teachers, Parents, Humanists	20	20

Tab. 3: Structure of the sample, amount of participants for each group and participation rate after the third attempt

2 Qualitative analysis

2.1 Method

In the present case, we resourced to content analysis in order to analyse qualitative data obtained in the questionnaire composed by three open questions. Considering the nature of the material to explore, as well as the need to proceed to the "manipulation" of messages (content and content expression), the content analysis technique seemed to have enough potentialities to make messages and contents intelligible.

Content analysis must be permanently reinvented, bearing in mind the investigated problems and their goals. There is not a fix model for the referred analysis but only some base norms (Bardin,

2009). Therefore, we indicate here some of these rules and considerations to attend to when one uses this technique, so that interpretation does not put research at stake. According to Bardin (2009):

> "The different stages of content analysis, such as sociological enquiry or experimentation, organize around three chronological poles:
>
> 1) Pre-analysis
> 2) Material exploration
> 3) Result treatment, inference and interpretation" (p. 121).

The same author considers that at stage 1 there are three missions one should undertake: the choice of documents to be submitted to analysis, the formulation of hypothesis and goals and the elaboration of indicators which ground the final interpretation (Bardin, 2009). These factors are not necessarily successive chronologically, even though tightly connected to each other.

The importance of category definition is very significant, since collected information systematization and the elaboration of inferences depend of that definition. Analysis categories should aim to be: free from ambiguities and inconsistencies, cover all formal needs and give enough information.
Once built, content analysis categories should be subjected to an internal validity test in order that the researcher guarantees its exhaustivity and exclusivity. One intends to assure, in the first case, that all register units may be placed under one of the categories; and, in the second case, that a same register unit may fit in one category.

On what concerns the second stage of content analysis, material exploration, this becomes pertinent before the analysis itself. This stage consists, essentially, on codification operations, decomposition or listing, applying the decisions made in the pre-analysis stage (Bardin, 2009). A passage can receive more than a code, if it contains two or more meanings. The text is divided in data units: blocks of information that will be analysed altogether, and whose dimension may vary – from one sentence to a simple definition, from several paragraphs to telling a story, which constitutes a coherent whole (Rubin & Rubin, 2005).

At last, result treatment, inference and interpretation aim to validate the results and make them meaningful. After, systematically codifying the material one tries to extract meaning from those results. With the data assembled, one looks for patterns and connections between the themes and a narrative description of events, which bears in mind the different views analysed. Finally, one looks for implications for the results and defines in which circumstances these may apply (Rubin & Rubin, 2005).

In qualitative data analysis we used WebQDA software (Web Qualitative Data Analysis). It is qualitative data analysis software for use in collaborative distributed environments (www.webqda.com). In spite of the fact that there are some applications that deal with non-numeric and unstructured data (texts, multimedia) for qualitative analysis, none of them can be used by several researchers in a collaborative distributed environment as the Internet can offer. WebQDA is software especially useful for researchers, both in academic and business contexts, who require qualitative data analysis individually or collaboratively, synchronously or asynchronously. The WebQDA follows the structural and theoretical design of the most used proprietary software – NVivo, Atlas.ti, MaxQDA –, with the main difference that it will offer the ability to work collaboratively online in real time along with a research support service. In this paper we present the

theoretical structure and main functions of WebQDA and its applicability and versatility in various types of research designs.

2.2 Results

After the analysis of the answers obtained for each question, we established the categories indicated in Table 4.

Question	1	2	3
Answer Categories	1. Environment 2. Technology 3. Daily life 4. Nature 5. Experimental practices 6. Health 7. Security	1. Natural resources and sustainability 2. Energy 3. Constitution of the Universe 4. Education for health 5. History of Science 6. Materials, properties and chemical transformations 7. Traffic prevention and security 8. Movements and forces 9. Sound	1. Curiosity and questioning 2. Logical thinking 3. Critical thinking 4. Innovation and creativity 5. Respect for the planet and its preservation 6. Intellectual and civic integrity 7. Working in group 8. Digital skills 9. Problem solving 10. Analysis, synthesis and research 11. Interest for Science

Tab. 4: Table of the categories differentiated according to the three questions in the questionnaire.

2.3 Discussion

In what concerns situations, with what motivations and in what context should sciences be taught (question 1) most answers pointed to daily life, the closer and more familiar situations to the student as a trigger context of a better Science teaching. We also registered a considerable number of answers referring to practical-experimental situations and contexts related to maintenance of general security of individuals in several scenarios as a good starting point for Science teaching.

According to the majority of the elements of the sample, the contents/themes related with sciences to be approached in science classes (question 2) relate to knowledge of natural resources, how to obtain and use them, and also with ways of sustainability preservation of planet Earth. Also referred very often were ways and types of energy, energetic efficiency, electricity, and education for health, - sexuality, hunger, obesity, transgenics, basic notions of life rescue, growth and human development,.

Skills and attitudes to develop in science classes (question 3) are critical thinking, curiosity and questioning. Working skills in group dynamics and the ability to analyse, synthetize and research were frequently pointed out.

3 Quantitative analysis

3.1 Method

The use of WebQDA (software of data analysis, presented previously) allowed us to, besides the quantitative analysis, to determinate relative frequencies, later treated in order to generate the graphic representations below.

3.2. Objectivity of the data analysis

In what concerns the accuracy of results, which refer the degree of trust or exactitude on how we can rely on the obtained information, as Busch *et al*. refers (2005) the results should be independent from those who produce them. Hence, the accuracy tests will test the fidelity of the codifier and analysis categories. A set of codifiers, operating under the same text, should get to the same results in two different moments and analysing the text in two different moments, it should reproduce the same analysis. Accuracy is competed when the analysis category is not ambiguous, that is, enables the easy classification of the register unit. With this purpose, we recurred to experts and investigators in the area.

3.3 Results

Question 1

MATRIX	Environment	Health	Security	Nature	Experimental practice	Technology	Quotidian/ Lifestyle
Students	0,07	0,13	0,00	0,00	0,40	0,00	0,40
Teachers	0,15	0,08	0,21	0,05	0,05	0,08	0,38
Educators	0,00	0,00	0,00	0,00	0,00	0,00	1,00
Scientists	0,00	0,00	0,00	0,00	0,50	0,50	0,00
Politicians	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Non Sciences	0,00	0,07	0,07	0,07	0,40	0,00	0,40

Tab. 5: Relative frequencies for question 1.

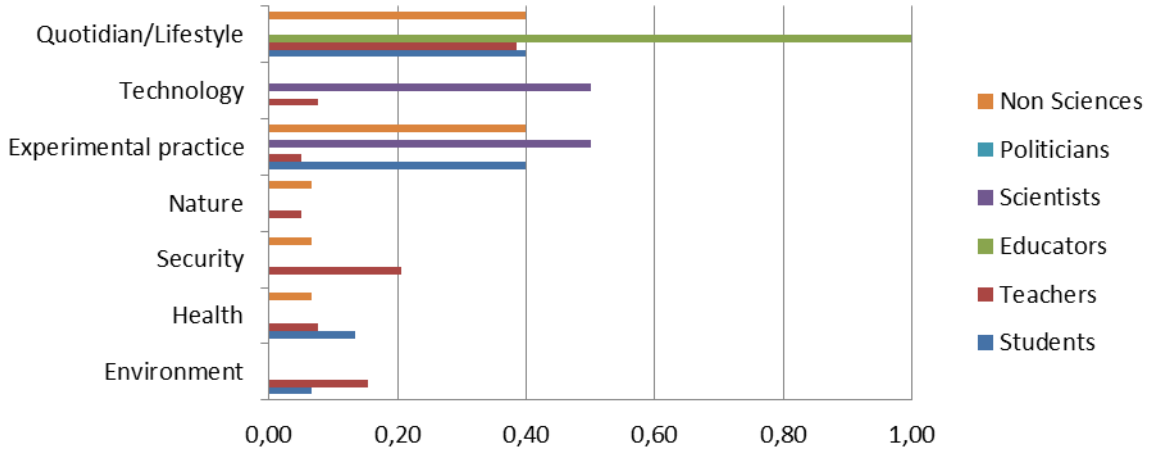

Fig. 1: Relative frequency of the categories regarding the statement bundle "situation and context" – percentage of the total sample and the four sub-samples.

Question 2

MATRIX	Natural resources and sustainability	Energy	Constitution of the Universe	Health education	History of Science	Materials, properties and chemicals transformations	Traffic prevention and security	Movements and forces	Sound
Students	0,11	0,00	0,00	0,22	0,00	0,22	0,00	0,33	0,11
Teachers	0,23	0,19	0,06	0,03	0,06	0,13	0,13	0,10	0,06
Educators	0,00	0,00	0,00	1,00	0,00	0,00	0,00	0,00	0,00
Scientists	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Politicians	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Non Sciences	0,29	0,00	0,00	0,29	0,14	0,14	0,00	0,14	0,00

Tab. 6: Relative frequencies for question 2.

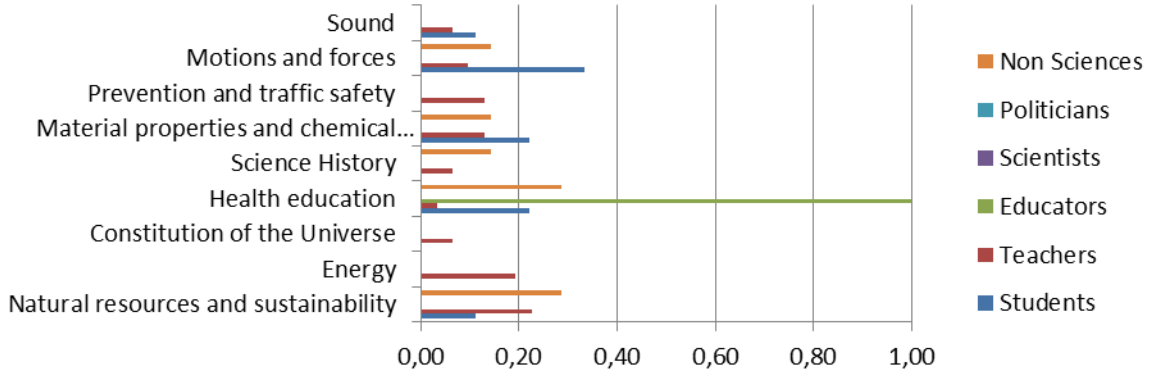

Fig. 2: Relative frequency of the categories regarding the statement bundle "themes and contents" – percentage of the total sample and the four sub-samples.

Question 3

MATRIX	Curiosity and inquiry	Interest for science	Logical thinking	Critical thinking	Innovation and creativity	Respect for the Planet and its preservation	Intellectual and civic integrity	Group work	Digital skills	Problem solving	Analysis, synthesis and research
Students	0,00	0,00	0,00	0,00	0,20	0,00	0,40	0,00	0,20	0,20	0,00
Teachers	0,13	0,11	0,11	0,16	0,05	0,08	0,03	0,13	0,03	0,11	0,08
Educators	0,00	0,00	0,00	0,50	0,00	0,00	0,50	0,00	0,00	0,00	0,00
Scientists	0,00	0,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Politicians	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Non Sciences	0,21	0,00	0,07	0,21	0,07	0,00	0,07	0,07	0,07	0,07	0,14

Tab. 7: Relative frequencies for question 3.

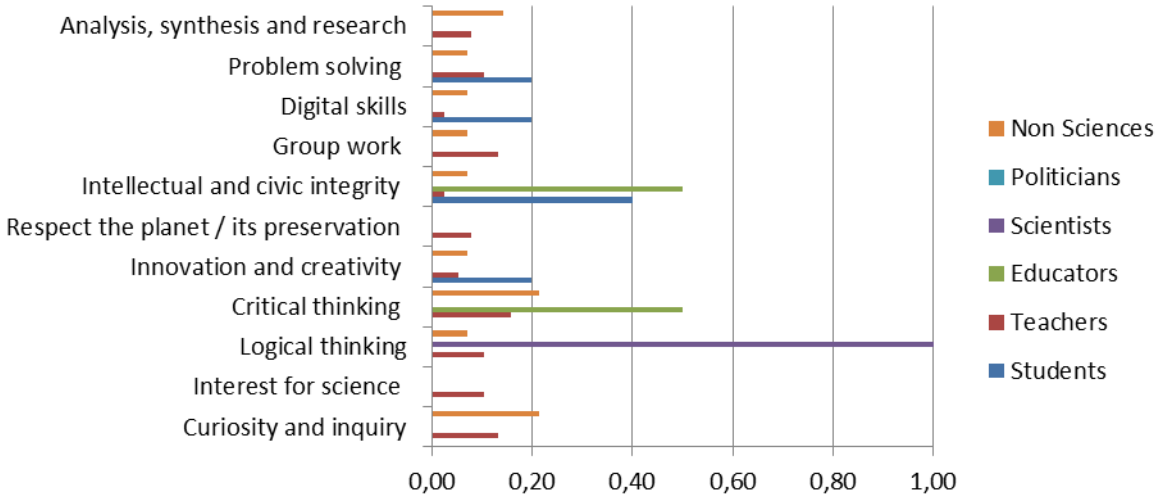

Fig. 3: Relative frequency of the categories regarding the statement bundle "aptitudes, skills and attitudes" – percentage of the total sample and the four sub-samples.

3.4 Discussion and remarks

Question 1

As situations/contexts as starting points for science teaching are concerned, most students non-scientific elements considered that the practical-experimental situations and quotidian/Lifestyle were the most adequate for such role. Teachers and educators considered that daily situations the most indicated to initiate and contextualize science teaching. The scientists divided their opinion between practical-experimental situations and technology.

Question 2

According to student opinion, contents/themes that should be approached in class are, for most of them, movements and forces, followed by health education and materials, properties and chemicals transformations with same responses number. Teachers main responses told natural resources and sustainability followed by energy. Educators mentioned health education. The same was also mentioned by non-scientific elements that also pointed out themes related to natural resources and sustainability.

Question 3

In what concerns competences, skills and attitudes, we verified a great variability of answers in the different sample groups, since these were distributed approximately by the different defined categories. It is relevant, however, to highlight that curiosity and questioning, the development of critical thinking, logical thinking, group work and Intellectual and civic integrity played a major role in the remaining categories.

To summarize, it is important to underline the high rate of unanswered answers in the questionnaire which, even after several attempts, revealed the low representation of some sample groups, like educators, politicians and scientists. We should also highlight the great difficulty showed by in understanding questions and consequent explanation of answers. Such fact justifies that in numerous situations answers are not in harmony with the aim of the question which forced us to consider them unintelligible for our analysis.

4. **References**

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