PROFILES – WP3: Stakeholders Involvement and Interaction

PROFILES
Curricular Delphi Study on Science Education

Interim Report on the First Round of the UL, Slovenia Working Group

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1 Framework and procedure of the first round – participation rate

1.1 First attempt

In April 2011, altogether 188 participants ‘experts’ were asked via e-mail to fill out the PROFILES Delphi questionnaire (First round, 1st attempt). 22 experts gave feedback and sent back filled out answer sheets. On average only 12 % of all send questionnaires were returned. More detailed structure of the sample after the first attempt is presented in Table 1.

Table 1. Structure of the sample in Slovenian Delphi study, round 1, first attempt.

<table>
<thead>
<tr>
<th>group</th>
<th>subgroup</th>
<th>No. of sent que. / No. of returned que.</th>
<th>Response rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>students</td>
<td></td>
<td>35 / 3</td>
<td>6%</td>
</tr>
<tr>
<td>Science teachers</td>
<td>university students in the education programme studying either chemistry, biology, physics, geography, general sciences,…</td>
<td>12 / 0</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>trainee science teachers</td>
<td>15 / 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>science teachers</td>
<td>26 / 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>science trainee teachers educators</td>
<td>27 / 5</td>
<td></td>
</tr>
<tr>
<td>Educators, didactics, and in-service teacher educators</td>
<td>28 / 3</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>Scientists</td>
<td></td>
<td>32 / 5</td>
<td>16%</td>
</tr>
<tr>
<td>Education politicians</td>
<td></td>
<td>13 / 1</td>
<td>8%</td>
</tr>
</tbody>
</table>

As can be seen in Table 1, the response rate was very low. The first attempt featured especially low response rate in the sub-group of students (3 responses), university students in the education programme studying either chemistry, biology, physics, geography, general sciences (no responses), trainee science teachers (one response), science trainee teacher educators (3 participants), and education politicians (one participant). Because of the low response rate in first attempt to gather data about science education in Slovenia and because there is a low number of potential participants in some sub-groups we decided to send a reminder to the selected participants in the first attempt, and after the second reminder via e-mail, a response rate increased. Participants usually responded that they forgot to respond to the questionnaire and that they appreciate for reminding them to do so.
1.2 First and second reminder

Table 2 shows a more detailed description of the participants in the Curricular Delphi Study on Science Education in Slovenia after the second reminder. 108 (57%) experts had taken part in the first round of the study by e-mail. Others were not willing to participate in the study not even by regular mail that was offered as an option.

<table>
<thead>
<tr>
<th>Group</th>
<th>Subgroup</th>
<th>no. of sent que. / no. of returned que.</th>
<th>Response rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students</td>
<td>students at school without advanced science courses</td>
<td>40 / 14</td>
<td>35 / 26</td>
</tr>
<tr>
<td></td>
<td>students at school with advanced sciences courses</td>
<td>40 / 12</td>
<td></td>
</tr>
<tr>
<td>Teacher students and trainee teachers</td>
<td>university students in the education programme studying either chemistry, biology, physics, geography, general sciences,...</td>
<td>12 / 3</td>
<td>27 / 12</td>
</tr>
<tr>
<td>(young “teachers”)</td>
<td>trainee science teachers</td>
<td>15 / 9</td>
<td></td>
</tr>
<tr>
<td>Teachers and trainee teachers (experienced teachers)</td>
<td>science teachers</td>
<td>26 / 15</td>
<td>53 / 27</td>
</tr>
<tr>
<td></td>
<td>science trainee teachers educators</td>
<td>27 / 12</td>
<td></td>
</tr>
<tr>
<td>Educators, didactics, and in-service teacher educators</td>
<td>chemistry</td>
<td>5 / 4</td>
<td>28 / 20</td>
</tr>
<tr>
<td></td>
<td>physics</td>
<td>6 / 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>biology</td>
<td>6 / 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>geography</td>
<td>5 / 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>general science/primary science</td>
<td>6 / 5</td>
<td></td>
</tr>
<tr>
<td>Scientists</td>
<td>chemists</td>
<td>21 / 12</td>
<td>32 / 24</td>
</tr>
<tr>
<td></td>
<td>biologists</td>
<td>10 / 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>physicists</td>
<td>8 / 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>others</td>
<td>7 / 2</td>
<td></td>
</tr>
<tr>
<td>Education politicians</td>
<td>spokespersons for education policy</td>
<td>13 / 8</td>
<td>13 / 8</td>
</tr>
</tbody>
</table>

The first reminder went to the potential participants 7 days after the sending of the questionnaires. After the first reminder 41 more experts (altogether 63 or 34 % of all participants invited in the 1st round) responded. Because this sample was still too small we kindly asked in the second reminder experts to send us the fulfilled questionnaires. This was done 7 days after the second reminder. After this attempt 30 more questionnaires were returned to us, but still the group of students was the most problematic form the number of
answer sheets returned point of view only 11 secondary school students and 15 scientists answered the questionnaires. So in September 2011 we send 45 and 14 new questionnaires out to the secondary school students and scientists, respectively. After this attempt altogether 26 students and 24 scientists responded.

2 Qualitative analysis

2.1 Method

The statements we received from the 108 participants in the first round of the Curricular Delphi Study in Science Education. According to the qualitative analysis approaches (Vogrinč, 2008; Creswell, 2007) all responses of the participants were coded and codes were grouped, summarized and systematized within a category system presented in table 3. Categories were determined according to codes that were identified in all the questionnaires.

2.2 Results

As it can be seen in Table 3, the final classification system of the UL consists of a total number of 111 categories. Categories are in the specific part of the table structured alphabetically.

<table>
<thead>
<tr>
<th>I. Situations and motives of teaching</th>
<th>II. Context and content of teaching</th>
<th>III. Methods used in teaching</th>
<th>IV. Competences of 16-year-olds</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=34</td>
<td>N=12</td>
<td>N=24</td>
<td>N=26</td>
</tr>
<tr>
<td>assessment</td>
<td>biological context</td>
<td>adequate test items</td>
<td>application of knowledge in real situations</td>
</tr>
<tr>
<td>constructiveivist teaching approach</td>
<td>chemistry (everyday) context</td>
<td>case study</td>
<td>argumentation competences</td>
</tr>
<tr>
<td>context from everyday live/socio-scientific issues</td>
<td>economical context</td>
<td>concept maps learning</td>
<td>ICT competences</td>
</tr>
<tr>
<td>cooperative learning</td>
<td>environmental context and recycling</td>
<td>cooperative learning</td>
<td>modelling competences</td>
</tr>
<tr>
<td>critical/creative/scientific reasoning</td>
<td>ethical aspects of scientific progress</td>
<td>critical thinking</td>
<td>research work/experimental competences</td>
</tr>
<tr>
<td>cross-curricular connections</td>
<td>industry context</td>
<td>cross-curricular topics</td>
<td>problem solving/decision making competences</td>
</tr>
<tr>
<td>differentiation in teaching</td>
<td>integrated science</td>
<td>developing responsibility</td>
<td>learning competence</td>
</tr>
<tr>
<td>emphatic relation to science</td>
<td>Nobel prize context</td>
<td>discussions</td>
<td>competences for active work</td>
</tr>
<tr>
<td>essays writing</td>
<td>physical context</td>
<td>field work</td>
<td>competences for ethical aspects</td>
</tr>
<tr>
<td>exercises</td>
<td>real live science situations</td>
<td>homework</td>
<td>competence for critical reasoning</td>
</tr>
<tr>
<td>experimental/practical/IBSE teaching approaches</td>
<td>science phenomena selected by the students</td>
<td>IBSE/experimental/project/practical work</td>
<td>mathematical competence</td>
</tr>
<tr>
<td>family influence</td>
<td>science and art</td>
<td>ICT</td>
<td>competence for</td>
</tr>
<tr>
<td>field work</td>
<td>science and war</td>
<td>individual work</td>
<td></td>
</tr>
<tr>
<td>good teaching material</td>
<td>science in free time</td>
<td>informal education</td>
<td></td>
</tr>
<tr>
<td>individual students’ learning approaches</td>
<td>story telling and science education</td>
<td>information search in the literature</td>
<td></td>
</tr>
<tr>
<td>informal teaching and</td>
<td></td>
<td>learning with</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 2.3 Discussion

Categories that were formed according to the codes identified in the response sheets obtained from the participants of the Delphi science education curriculum study were divided into four parts according to the questions in the questionnaire. In part I (Situation, context, motive for teaching) 34 categories were developed. Part II (Context and content of teaching) consisted total of 27 categories. The sub-parts Ila (Context) and IIb (Content), consists of 12 and 15 categories respectively. Part III (Methods used in teaching) contains 24 categories and the last part IV (Competences of 16-year-olds) consisted of 26 categories.

It is possible to conclude that participants described in the first question that was about motives for science learning the most thoroughly. From their statements can be concluded that participants see different aspects of effective science learning in the primary and secondary school. They listed different aspects connected with active learning approaches with content refereeing to the students’ (peoples) everyday live, teachers’ attitude towards teaching, students’ interest in learning science subjects and also the national positive support of the school system.

Participants listed mostly novel and actual contents on which school science subject could and should take content from. Contexts and contents (part II) are especially related to form the participants’ point of view, interesting for students’ like science in forensics, sport, health, free time... and also those that are connected to societal context, like energy, radioactivity, environment, economy, industry...
In the third part of the questionnaire participants had to write those teaching methods that they think can help students learn science concepts. They listed different methods and approaches like cooperative learning, IBSE, ICT, problem solving, visualization... All these approaches are also important in the PROFILES philosophy. It can be estimated that participants would list 16-years-olds’ competences in science, that are connected with the previously mentioned content and motives for adequate science knowledge. They estimated that an average 16 years old student should develop competences related to hers/his health, problem solving and decision making in the live, cooperative work, using ICT, and basic scientific literacy.

3 Quantitative analysis

3.1 Method
The relative frequencies of the categories were determined by using EXCEL. To each category one code (statement) was assigned. This means that, for example, the field of alcohol, organic acids, etc. would only be counted once in the category “organic chemistry”. If a category is mentioned in a formsheet, it should be coded with “1”, the categories that are not mentioned are then coded with “0” for that particular formsheet and particular participant. The relative frequencies were then calculated for each category regarding the whole sample of participants or the number of participants in the specific sub-group.

3.3 Results
From figure 1 to 24 for each part of the questionnaire (Part I - Situations and motives of teaching, Part II - Context and content of teaching, Part III - Methods used in teaching and Part IV - Competences of 16-year-olds), for each sub-group of participants and total relative frequencies are presented.
### 3.3.1 Results of the categories analysis of the “situation/context/motive” part of the questionnaire

![Relative frequency of the categories regarding the codes “situation/context/motive” – percentage of the total sample.](image)

It can be seen that almost all participants in the Delphi curriculum science education study presented on figure 1, emphasised that experimental work in its broader form is the most important part of the science education. More than 80 % of participants also mentioned that science teachers’ knowledge is important for adequate and successful students’ learning of science concepts. More that 50 % participants of participants mentioned that context from everyday live/socio-scientific issues, students' motivation, students' understanding of basic and important content, critical/creative/scientific reasoning, problem (authentic) solving and teachers' teaching strategies, this can indicate that also these aspects of science education in Slovenian school are very important.
Figure 2: Relative frequency of the categories regarding the codes “situation/context/motive” – percentage of the sub-group Educational Politicians.

Similar results, as described for the total sample of participants, can be seen for the sub-group sample of Educational Politicians that lead teachers’ professional development and implementations of innovations and reformed national curriculums in the school. The most obvious difference is, that more than 50% of them emphasises also problem (authentic) solving, teachers’ motivation for teaching, cross-curricular connections, and cooperative learning. It is also important to emphasise that 7 categories were not mentioned by this sub-group of participants.
Figure 3: Relative frequency of the categories regarding the codes “situation/context/motive” – percentage of the sub-group Scientists.

As mentioned above Scientist mentioned similar aspects of effective science education in Slovenian schools, and they also emphasised that interesting science content should be used in schools, effective teachers’ education should be ensured, students’ logical thinking should be stimulated and this could be achieved also by national reform/support of school system (science education) and adequate teachers’ teaching strategies. Four categories were not mentioned by Scientists.
Similar results as in the above sub-groups were also obtained by the analysis of the responses of the Science Teachers Educators, but they also emphasised that students should have opportunities to learn outside classroom (field work) and that science education should be supported by using different visualization strategies to illustrate science phenomena.
Figure 5: Relative frequency of the categories regarding the codes “situation /context /motive” – percentage of the sub-group Science Teachers.

It can be determined by analysing science teachers’ responses that they have similar views on science education as others sub-groups. Teachers, as those who are the most important actors in science education, because they implement all the aspects of the education in the classroom, mentioned all the selected categories.
Students listed the least categories as determined by the analysis of the responses. Students mentioned most frequently the same categorise as the other sub-groups but it is important to emphasised that according to students’ experiences from the other aspect of school science education they left out some (7) categories.
3.3.2 Results of the categories analysis of the “context and content of teaching” part of the questionnaire

![Relative frequency of the categories regarding the codes “context and content of teaching” – percentage of the total sample.](image)

Regarding the whole sample of participants it can be concluded that according to the context and content of science education in Slovenian schools the most participants emphasised that real live science situations should be used in science teaching. More than 40 % of them also think that biological, environmental and everyday chemistry context should be implemented into the school science. Other categories appear rarely in the participants’ responses.
Figure 8: Relative frequency of the categories regarding the codes “context and content of teaching” – percentage of the sub-group Educational Politicians.

Similar categories were listed by the Educational Politicians, but they also emphasised topic energy in more than 50%. Participants in this group have not listed 12 categories that were identified in the analyses responses.
Figure 9: Relative frequency of the categories regarding the codes “context and content of teaching” – percentage of the sub-group Scientists.

It can be seen from the figure 9, that scientist’s listed more categories connected with context and content of science teaching than education politicians. Scientists listed almost all categories, but the most scientists (92%) mentioned that some sort of real live science situations should be used in the science education at primary and secondary level.
Figure 10: Relative frequency of the categories regarding the codes “context and content of teaching” – percentage of the sub-group Science Teachers Educators.

Science teacher educators also listed in the most cases that real live science situations should be important as a context and content in the science education. More than 50% of participant in this sub-group also emphasises more general topics as: environmental context and recycling, biological and everyday chemistry context.
Figure 11: Relative frequency of the categories regarding the codes “context and content of teaching” – percentage of the sub-group Science Teachers.

Similar results were also determined by the analyses of the responses by Science teachers. In comparison with the above mentioned sub-groups only 38% of them emphasised that real live situations should be incorporated into the science education process, but more than 50% of them mentioned that more specific chemical and biological content should be used in teaching.
Figure 12: Relative frequency of the categories regarding the codes “context and content of teaching” – percentage of the sub-group Students.

Similar as in the first part of the questionnaire also in this one, students do not have a lot of ideas what to learn in science education, but it can be determined that more than 60% of them need to hear topics connected with the real live science situations and that other topics that are not connected with their live are not important. It is also interesting to mention that would almost 40% of the participants in this sub-group like to hear more about health topics.
3.3.3 **Results of the categories analysis of the “methods used in teaching” part of the questionnaire**

![Relative frequency of the categories regarding the codes “methods used in teaching” – percentage of the total sample.](image)

**Figure 13:** Relative frequency of the categories regarding the codes “methods used in teaching” – percentage of the total sample.

Similar than in the first question, also 91% of all participants mentioned that some kind of active learning and experimental work should be used as a method for teaching science in schools. More than 40% of all participants also emphasised that visualization and modelling, problem solving, cooperative learning, lectures/explanations in classrooms, field work and some sort of individual work should be used in the science lessons.
Figure 14: Relative frequency of the categories regarding the codes “methods used in teaching” – percentage of the sub-group Educational Politicians.

Similar results can be obtained by analysing Educational Politicians responses. But they also mentioned in more than 40% the importance of teaching critical thinking. 7 categories were not mentioned by this sub-group of participants.
Scientists emphasises the same categories as other sub-groups most frequently. 5 categories were not mentioned by scientists.
Figure 16: Relative frequency of the categories regarding the codes “methods used in teaching” – percentage of the sub-group Science Teachers Educators.

It is interesting to conclude, that Science Teachers Educators mentioned all the categories determined in this part of the questionnaire. It is also important to emphasise, that all participants in this sub-group mentioned some sort of experimental work as a part of science education process in the school. More than 80% of them also mentioned that problem solving and cooperative learning is important for students to learn science. In more than 50% of science teachers educators also emphasised that visualization methods and different modelling approaches. They also mentioned that informal education and individual work are an important and effective approach in science teaching.
Figure 17: Relative frequency of the categories regarding the codes “methods used in teaching” – percentage of the sub-group Science Teachers.

Similar as science teachers educators also almost all science teachers listed that experimental work is important method for teaching science in the schools. More than 50 % of them also mentioned that visualization and cooperative learning can influence science learning.
Similar results can be obtained by the analysis of students’ reports about using methods in science teaching. Students emphasised that experimental work, visualization and lectures are the most important aspects of effective science teaching. Students have not listed 7 categories as determined in the analysis.
3.3.4 Results of the categories analysis of the “competences of 16-year-olds” part of the questionnaire

It can be determined by analysing the 16-year-olds’ competences regarding science education that 26 categories were identified. Participants in the study indicated in 83 %, that students need to have developed competence to do research work in science. 59 % and 54 % of all participants also emphasised that 16-years-olds should be able to reason critically and understand science concepts, respectively. Participant also pointed out the importance of argumentation and learning competences that students should develop. Other competences were mentioned by less than 35 % of all experts that participated in the Delphi study.
Almost 90% of educational politicians mentioned that competence for critical reasoning and research work/experimental competences are important for students. More than 50% of them also emphasised that argumentation competences, understanding science concepts, learning competence, ICT competences, competences for using and analysing information, problem solving/decision making competences are also important for an educated 16-years-old student at the scientific field. Educational politicians have not mentioned 5 competences that were identified during the questionnaire analysis.
Scientist participating in the Delphi study pointed out slightly different competences in more than 50 % of all cases that the whole sample in average. They indicated that the most important competences (92%) for 16-year-olds in research work/experimental competences. Almost 80 % of them think that understanding science concepts is also important and 67% of all scientists think that mathematical competence is important as well. They also emphasised in more than 50 % of all cases that competence for critical reasoning and students’ self-responsibility are competences that should be developed in science education at primary and secondary school.

![Bar chart showing the relative frequency of competences](image)

**Figure 21:** Relative frequency of the categories regarding the codes “competences of 16-year-olds” – percentage of the sub-group Scientists.
Only three competences were identified in more than 50 % of all science teachers educators. These are research work/experimental competences, understanding science concepts and competence for critical reasoning.
Figure 23: Relative frequency of the categories regarding the codes “competences of 16-year-olds” – percentage of the sub-group Science Teachers.

Science teachers have similar views on the secondary students’ competences in science education. They also pointed out in more than 40% that research work/experimental competences, competence for critical reasoning, argumentation competences, understanding science concepts, and competence for cooperative work are important competences for 16-year-olds.
Comparing the results with other sub-groups of participant also in this case students listed fewer categories for their competences. The most students emphasised research work/experimental competences and understanding home science phenomena as important competences. They have not mentioned as much as 11 categories of competences identified analysing the responses in the questionnaires.

### 3.4 Conclusions

The aim of the analyses described in the previous part was to gain information about characteristic descriptive-statistical values and about the frequency mentioning the categories. The calculation of the different frequencies illustrates the emphases made in the statements of all participants. According to the participants’ statements, 34 categories were identified and especially strong focus was set on the categories regarding “different experimental work”, “science teachers’ knowledge”, “context from everyday live/socio-scientific issues”, “students’ motivation”, “students’ understanding of basic”, “critical/creative/scientific reasoning”, “problem (authentic) solving” and “teachers’ teaching strategies” (part I).
It can be concluded that according to the context and content of science education in Slovenian schools the most participants emphasised that “real live science situations” should be used in science teaching. More than 40% of them also think that “biological, environmental and everyday chemistry context” should be implemented into the school science (part II). In this part of the questionnaire 27 categories were determined. 24 categories were identified in the III. part of the questionnaire. Similar than in the first part of the questionnaire, 91% of all participants mentioned, that some kind of “active learning and experimental work” should be used, as a method for teaching science in schools. More than 40% of all participants also emphasised that “visualization and modelling”, “problem solving”, “cooperative learning”, “lectures/explanations in classrooms”, “field work” and some sort of “individual work” should be used in the science lessons.

It can be concluded that 26 categories were identified regarding 16-year-olds’ competences in science education (IV. part). Participants in the study indicated in 83%, that students need to have developed competence to do “research work” in science. 59% and 54% of all participants also emphasised that 16-years-olds should “be able to reason critically” and “understand science concepts”, respectively. Participant also pointed out the “importance of argumentation” and “learning competences” that students should develop.

4 References


Vogrinč, J. (2008). Kvalitativno raziskovanje na pedagoškem področju./Qualitative Research in the Field of Education. Ljubljana: University of Ljubljana, Faculty of Education.