Deliverable 5.5

Policymakers' Views on a Model of Science Education of the Society of Acceleration and Uncertainty – the FEDORA Concept

FEDORA – Future-oriented Science Education
to enhance Responsibility and engagement
in the society of Acceleration and uncertainty

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Dissemination level:

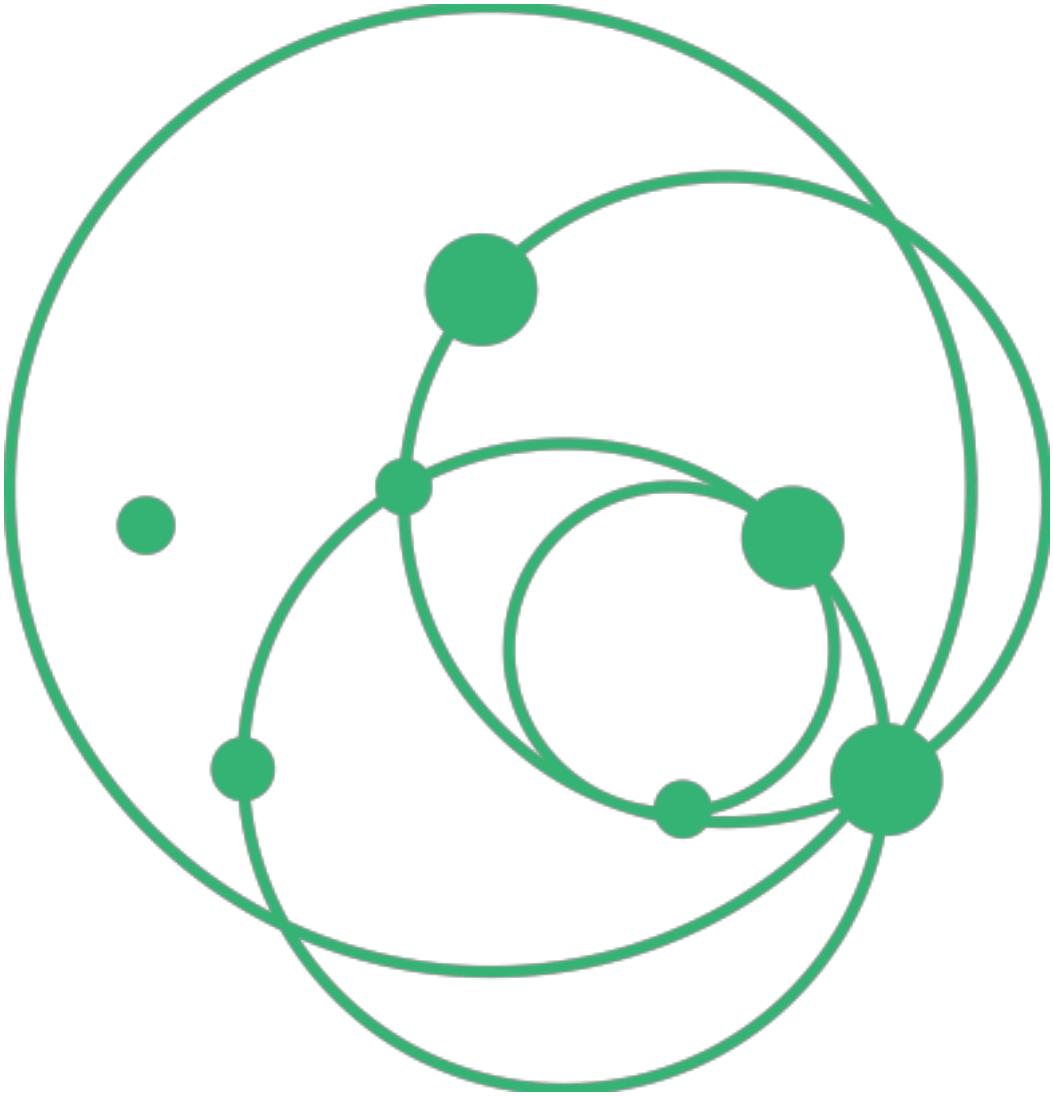
- Public

Quality assurance

In order to ensure the quality and accuracy of this deliverable, we employed a review and validation process internal to the FEDORA Project. The deliverable was supervised and edited by the work package leader (UOXF) and carried out by the main researcher at UOXF. All partners contributed to and reviewed the final version. Finally, the last version was submitted to the project coordinator for final review and validation.

Disclaimer

This deliverable contains original, unpublished work except where clearly indicated otherwise. It builds upon the experience of the team and related work published on this topic. Acknowledgement of previously published material and others' work has been made through appropriate citation, quotation, or both. The views and opinions expressed in this publication are the authors' sole responsibility and do not necessarily reflect the views of the European Commission.



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1. Description of WP5

Research activities of WP5 bear two action goals. The first action goal (T5.1-5.3), led by UOXF, is to produce policy briefs for FEDORA. While WP5 utilised information and materials from the other work packages (WPs) to inform its specific focuses, it also reciprocated other WPs by providing feedback insofar as it guides how other WPs can engage with policymakers. WP5 used Delphi methodology (Murray & Hammons, 1995) in its cycle of multiple tasks (T5.1-T5.3). These tasks aimed at assessing policymakers' views of and attitudes towards future-oriented science education. The assessment then became the basis for building an initial consensus. The second action goal of WP5 is to align MoRRI (Monitoring the evolution and benefits of Responsible Research and Innovation) indicators on science literacy and science education (SLSE) with the results produced by other WPs. This deliverable focuses on the first action goal on consensus building. Figure 1 illustrates the specific tasks for the policy brief action goal for FEDORA. Tasks 5.1 and 5.2 have been explained and reported in deliverables 5.1 – 5.4. This deliverable, D5.5, will give details on Task 5.3 – consensus building through the final-round of the Delphi survey.

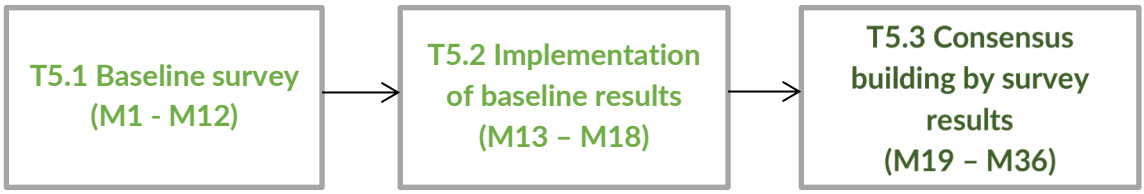


Figure 1 – WP5 tasks led by UOXF

2. Final round of Delphi study

2.1 Data collection

UOXF is the lead partner of task T5.3 and UNIBO, UH, and KTU are participating partners. To conduct a Delphi study, UOXF developed a questionnaire in each of the three rounds for seeking policymakers' views on future-oriented science education. The two earlier stages of the Delphi study, the question items of the questionnaires as well as the results, were explained in Deliverables 5.1 – 5.4.

In the third (and final) round of the study, a questionnaire was designed based on the results from the previous two rounds in accordance with the Delphi methodology. Delphi is *"a method for the systematic solicitation and collection of judgements on a particular topic through a set of carefully designed sequential questionnaires interspersed with summarized information and feedback of opinions derived from earlier responses"* (Delbecq, van de Ven, & Gustafson,

1975, p.10). Following this definition, the final-round questionnaire presented results from the previous round and asked respondents to indicate their perceived importance of those results. Since the goal of this final questionnaire was to come up with a consensus, by nature the research process purposefully reduced diverse opinions or new suggestions not emerged in the previous rounds. With this goal in mind, the final questionnaire had to exclude some peripheral results from the second round, and drew the participants' attention to the more popular views voted by the majority.

Except demographics questions, the final-round questionnaire comprised ten closed-ended ranking questions in three main types – views on future-oriented skills, policymakers' recommendations and *European sustainability competence framework* (Bianchi et al., 2022). Participants were asked to rank the importance of various options in each of these ten opinion questions. However, they could submit comments in each question if they wished to. The questions iterated some items or ideas from the two earlier rounds so participants were well familiar with the questionnaire and its purpose. This data collection process is interactive because the final questionnaire informed our participants about the views expressed by the majority; meanwhile they had a chance to submit their judgements, compromised or not, in consideration of the dominant views. Our goal is to create a tendency of convergence built upon some diverse opinions (Hsu & Sandford, 2007).

The questionnaire was sent to all the 22 participants who responded in Round 2 of the study. 18 of them responded to the final-round questionnaire, yielding 82% of response rate. These 18 experts and policymakers became the final sample of the consensus building. The questionnaire is attached in the Appendix of this deliverable.

2.2 Data analysis

Data about the demographic questions were summarised to show the variety of backgrounds of the participants. Bearing the goals of consensus building and recommendations for policymaking, the ten opinion and ranking questions were analysed using quantitative techniques. Analyses of each of the questions took three steps.

Firstly, descriptive statistics was conducted to provide a summary and the distribution of rankings of each option. For example, Table 1 shows the relevant statistics of each of the options in the question about the *European sustainability competence framework*.

Statistics

		Collective_action	Exploratory_thinking	Individual_initiative	Adaptability	Futures_literacy	Political_agency
N	Valid	18	18	18	18	18	18
	Missing	0	0	0	0	0	0
Median		3.00	2.00	4.00	3.00	3.50	6.00
Mode		1	1[a]	4	1[a]	5	6
Minimum		1	1	2	1	1	1
Maximum		6	6	6	5	6	6

a. Multiple modes exist. The smallest value is shown

Table 1 – Descriptive statistics results

Next, a mean rank was also calculated for each option to determine its average weight rated by all the respondents. In this way, the most agreed options, operationalised as their average rankings of significance in response to a particular question item, can be settled by arranging all the mean ranks in order. Table 2 shows the mean ranks of the various options in the sustainability competence question. The results show that exploratory thinking (M = 2.67), adaptability (M = 2.89) and collective action (M = 2.94) are voted as the three most important competence proposed by the European framework.

Ranks

	Mean Rank
Collective_action	2.94
Exploratory_thinking	2.67
Individual_initiative	3.89
Adaptability	2.89
Futures_literacy	3.67
Political_agency	4.94

Table 2 – Mean ranks of different options (NB – the lower the value, the higher the importance)

The metrics in Table 2 show that the differences between the mean ranks of each option are small. This entails that the rankings made by the panel did not come to a strong agreement or tendency. In fact, this question recorded the lowest agreement of all the opinion questions, i.e., consensus on which of these six options are the more important competence within the European framework is rather weak. This result is further supported by the third step of the analysis.

The third step is to calculate the strength of consensus. To achieve this, Kendall's coefficient of concordance was calculated to transform the variance in rankings into an indicative number (Kendall & Gibbons, 1990; Field, 2005). Looking across the coefficients of the ten ranking questions enables us to identify the issues on which the panel reaches general

consensus while at the same time what issues they agree less with each other. Kendall's method thus allows the researcher to evaluate and compare the strength of consensus about the variables, so it is an effective measure adopted by many Delphi studies (Gisev et al., 2013). Table 3 shows the Kendall's statistics of the European framework question (W = .208), which indicates a weak agreement between our expert respondents (Schmidt, 1997).

Test Statistics

N	18
Kendall's W[a]	.208
Chi-Square	18.730
df	5
Asymp. Sig.	.002

a. Kendall's Coefficient of Concordance

Table 3 – Kendall's statistics

3. Participant background

This section provides information about the demographics of the participants in the final phase of the Delphi study. Figures 2 to 6 illustrate a summary of the background of the participants. Figure 2 presents the distribution of the countries in which our respondents were based. Figure 3 shows the gender distribution of the 18 respondents. Figure 4 shows the highest degree the respondents have attained.

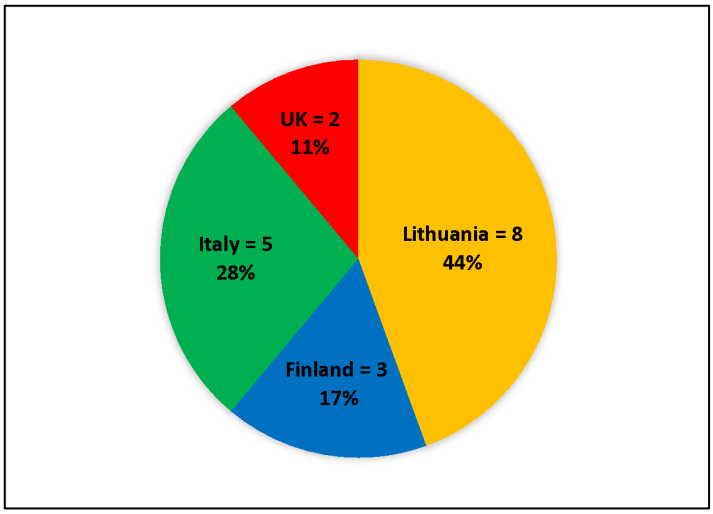


Figure 2 – Base country of the participants (n = 18)

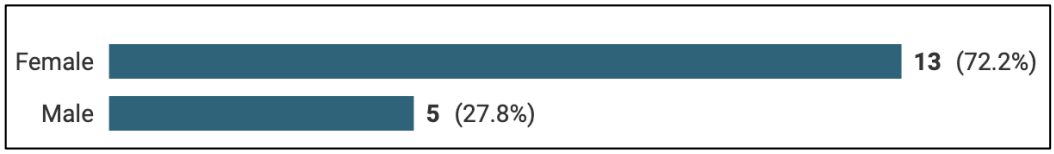


Figure 3 – Gender distribution (n = 18)

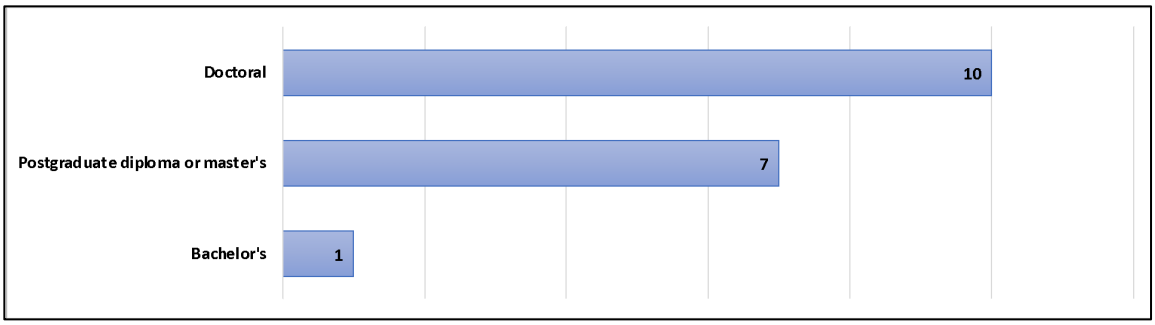


Figure 4 – Highest degree attained by the participants (n = 18)

In terms of education background, participants could choose more than one option so the total number exceeds 18. Figure 5 shows the subjects they have studied.

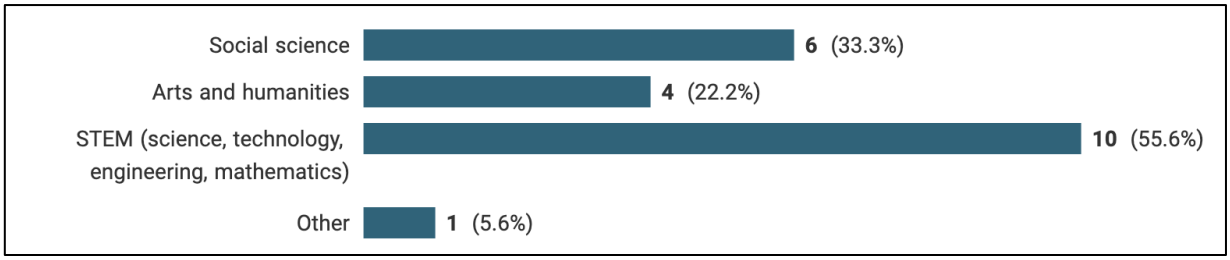


Figure 5 – Subjects studied by the participants

All participants (but one) have teaching experience at various school phases. Figure 6 displays the subjects they have taught. Participants could choose more than one option, so the total number exceeds 18.

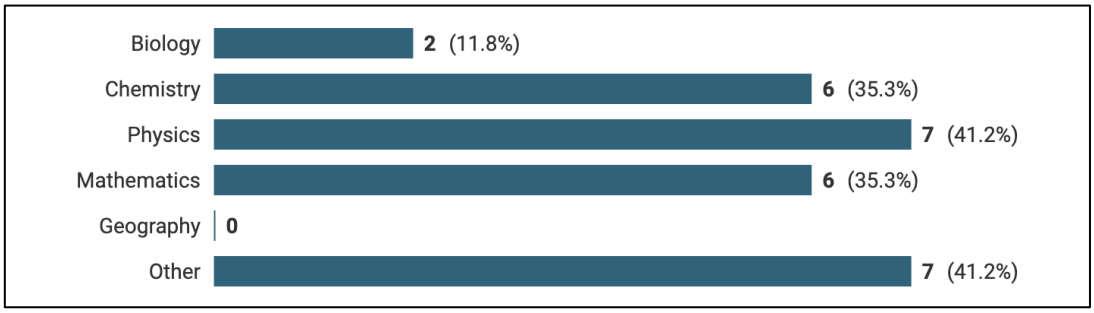


Figure 6 – Subjects taught by the participants

4. Elements of consensus on future-oriented science education

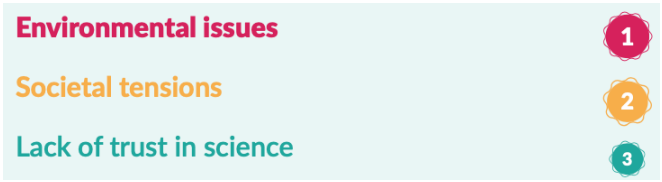
This section presents the consensus on ten issues obtained by the final-round questionnaire. These results are presented in descending order of consensual level. In other words, the first result (4.1) has the strongest consensus of all the ten issues (i.e., highest agreement reached by the Delphi panel), and the last result (4.10) has the lowest degree of agreement. Within

each issue, the three highest-rated options are listed in red, with descending order of significance in yellow and green.

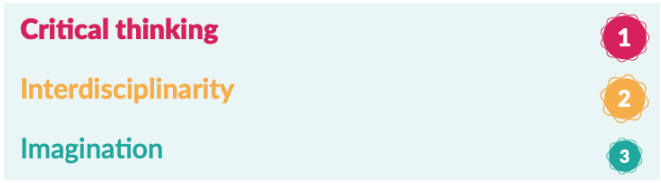
4.1 *How can the competencies for imagining the future and addressing future challenges be integrated into science education?* (highest agreement of all opinion questions)

4.2 *What key competencies will students need to address future challenges in science and the society?*

4.3 *What are the central challenges for science and the future society?*

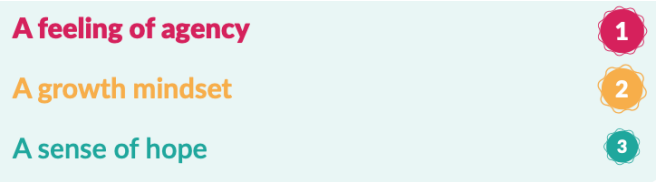


4.4 *What are the competencies students need for envisioning the future?*



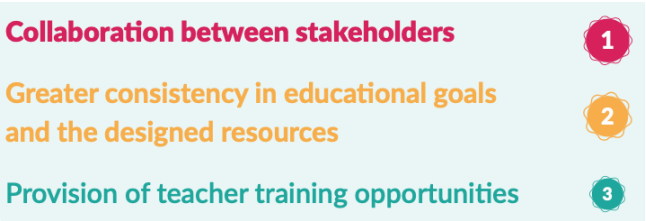
4.5 *What are the major obstacles to uptake of research in policymaking process?*

4.6 *What does it require for students to think about their own future?*

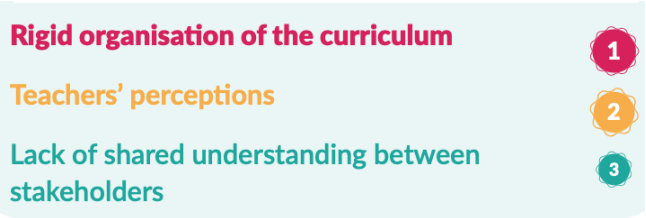


4.7 *What does it require for students to think about the global future?* (= equal ranking)

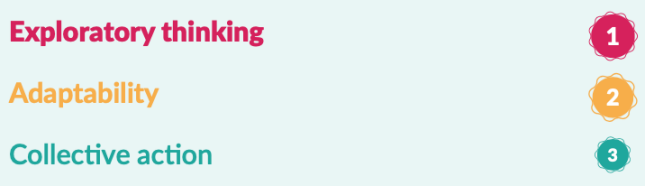
4.8 *What are the key components of effective policy to foster future-oriented skills?*



4.9 *What are the obstacles to reform of science education?*



4.10 *How significant are the statements from the European sustainability competence framework?* (lowest agreement of all opinion questions)



5. Recommendations

It is noteworthy that the consensus reached simultaneously offers recommendations for

policymaking or practice. The list of options within each sub-section 4.1-4.10 illustrate the recommendations for the respective issues attempted. For instance, the recommendations for (and consensus on) integrating competencies for imagining the future and addressing future challenges are (a) inclusion of interdisciplinary approaches; (b) promoting imagination / creativity; and (c) inclusion of socio-scientific issues. This logic applies to all other results presented above.

Some conclusive statements can be drawn before teasing out the implications for future work and recommendations for policymaking. First, the overall results show that higher agreement level is achieved on questions related to identifying future challenges and competency-based issues. Specifically, the Delphi panel tended to agree relatively strongly on the kinds of challenges that lie ahead of our next generations, and what skills or competencies students will need to cope with those challenges. Consequently, it can be concluded that the policymakers and experts have built a stronger consensus on what the future challenges are, the competencies students will need to address future challenges and the specific ways to integrate those selected competencies into science education.

Second, the issues related to aspects of policymaking or reform recorded relatively lower agreement level. The Delphi panel holds divergent views about the key components of effective policy to foster future-oriented skills in science education and the obstacles to achieving that. Amongst all the ten opinion-based issues, the comparative significance of different competence within the *European sustainability competence framework* has produced the least agreement within the panel group.

Above all, the WP5 results have shed light on the agreed priorities or directions for the future of science education amongst policymakers and experts in four European countries. Considering the lack of research or consensus on this pressing topic, especially regarding connecting it to policymaking, FEDORA has provided some useful pointers, new possibilities and areas of potential future research. Based on the results of this trailblazing study from FEDORA, recommendations can be made in two folds. First, stakeholders in the wider community can review or evaluate their policy or curricular related to science education. For example, experts in curriculum design or high-stake/national assessment can examine to what extent the objectives of their existing designs are in line with the common understandings, or have any remarkable divergence from the consensus built by this study. Second, practitioners such as school managers, teachers and teacher educators should enrich the discourse by expressing their opinions of this consensus. Communicating what is understood across stakeholder communities is an essential step towards meaningful discussion and engagement. Having the knowledge of policymakers' consensus will enable practitioners (and researchers) to engage with and contribute to the discussion more responsively, effectively and constructively. To this end, the FEDORA team invites audience at any capacity to give feedback on the consensus presented in the deliverables.

FEDORA Project

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Appendix

Views on future-oriented skills

Ranking questions

Each question below is presented with categories. Please rank the categories in order of importance - '1' being the most important category, then '2' and '3' being less and less important categories and so on.

For each category, the 'M' within the brankets indicates the mean (average) value of agreement from the respondents' answers in Round 2 of the survey. That means the higher the mean value, the more important the category is as viewed by the respondents. Please note that the 'M' reflects the collective results in Round 2. You can re-arrange the categories to indicate their importance based on your own views.

15. In your opinion, what are the central challenges for science and the future society? Please rank the categories in order of importance.

	1	2	3	4	5	6	7
Environmental issues (M=5.8)							
Societal tensions (M=4.7)							
Lack of trust in science (M=4.5)							
New diseases or viruses (M=3.8)							
Economic issues (M=3.8)							
Automatisation (M=3.4)							
Other (M=1.9)							

15.a. Comments

16. What key competencies students will need to address the future challenges in science and the society? Please rank the categories in order of importance.

	1	2	3	4	5	6	7	8
Critical thinking skills (M=6.6)								

Problem-solving skills (M=5.6)								
Creativity (M=4.9)								
Social intelligence (M=4.6)								
Digital skills (M=4.2)								
Meta-cognitive skills (M=4.1)								
Communication skills (M=4)								
Other (M=2)								

16.a. Comments

17. What competencies students need for envisioning the future? Please rank the categories in order of importance.

	1	2	3	4	5	6
Critical thinking ((M=4.5)						
Interdisciplinarity (M=4)						
Creativity (M=3.9)						
Problem-solving (M=3.8)						
Imagination (M=3.2)						
Other (M=1.6)						

17.a. Comments

18. How can these competencies for imagining the future and addressing future challenges be integrated into science education? Please rank the categories in order of importance.

	Inclusion of interdisciplinary approaches (M=5.6)	Promoting imagination / creativity (M=5.5)	Inclusion of socio-scientific issues (M=4.8)	Project - based learning (M=4.7)	Promoting collaborative skills (M=4.7)	Inclusion of various stakeholders in designing curricular (M=4.5)	Reducing focus on content (M=4.1)	Other (M=2.1)
1								
2								
3								
4								
5								
6								
7								
8								

18.a. Comments

19. What are some obstacles to educational reform with regard to science education? Please rank the categories in order of importance.

	Rigid organisation of curricular (M=4.2)	Teachers' perceptions (M=4)	Lack of a shared understanding between stakeholders (M=4)	Teachers' skills (M=3.8)	Lack of available resources (M=3)	Other (M=2)
1						
2						
3						
4						
5						
6						

19.a. Comments

20. To think about their own future (i.e. their future as an individual), students should have:

	1	2	3	4	5
a feeling of agency (M=3.8)					
a growth mindset (M=3.8)					
a sense of hope (M=3)					
a vision for their future careers (M=2.7)					
Other (M=1.7)					

21. To think about the global future (i.e. their future as citizens in a globalised society), students should:

	1	2	3	4	5
have a feeling of agency (M=3.9)					
be informed about global issues (M=3.4)					
be aware of the impact of their actions on the environment (M=3.4)					
develop perspective-taking skills (M=3)					
other (M=1.3)					

Policymakers' recommendations

22. What do you think are the major obstacles to uptake of research in the policymaking process? Please rank the categories in order of significance.

	Limited openness by politicians (M=7.4)	Policymakers' insufficient understanding of research evidence (M=7.3)	Traditional decision-making process (M=6.9)	Lack of political will (M=6.4)	Jargon not correspond with policy environment (M=5.7)
1					
2					
3					
4					
5					

22.a. Comments

23. What do you think are the key components of effective policy to foster future-oriented skills? Please rank in order of importance.

	1	2	3	4	5
Collaboration between stakeholders (e.g. teachers, policymakers, students) (M=4)					
Provision of teacher training opportunities (M=3.6)					
Greater consistency in educational goals and the designed resources (M=3.3)					
Greater emphasis on addressing fundamental educational needs (M=2.9)					
Other					

23a Comments

Sustainability competence

In January 2022, the European Commission published the *European sustainability competence framework*. It aims to provide a shared competence framework on sustainability in Europe as a common basis to guide educators and other stakeholders.

Given your expertise in education policy in your country, we would like to hear your views on some of the competencies presented in this framework.

24. To what extent do you think the following statements are significant? Please rank the statements in order of significance.

	1	2	3	4	5	6
Collective action: To act for change in collaboration with others (M=4.7)						
Exploratory thinking: To adopt a relational way of thinking by exploring and linking different disciplines, using creativity and experimentation with novel ideas or methods (M=4.5)						
Individual initiative: To identify own potential for sustainability and to actively contribute to improving prospects for the community and the planet (M=4.3)						
Adaptability: To manage transitions and challenges in complex sustainability situations and make decisions related to the future in the face of uncertainty, ambiguity and risk (M=4)						
Futures literacy: To envision alternative sustainable futures by imagining and developing alternative scenarios and identifying the steps needed to achieve a preferred sustainable future (M=4)						
Political agency: To navigate the political system, identify political responsibility and accountability for unsustainable behaviour, and demand effective policies for sustainability (M=3.7)						

24.a. Comment