Transversal Competencies in Research Careers

Preliminary results of the Catalisi predictive study

Task 3.3 Predictive Study Overview

The predictive study's objectives are twofold: 1) **assess the current level of soft skills of PhD students** in the EU across all research disciplines, 2) **understand if there is a mismatch with labour market requirements**, and 2) **forecast soft skills** that will become increasingly more important in the next 5 to 10 year for PhD students entering the labour market.

In the first phase of the study, the focus is on understanding the **as-is situation**:

Tool	Target	Objective	Progress
Literature review	Secondary sources, peer-reviewed studies	Understand current gaps in the field	**Complete**
Questionnaire	Over 1,700 PhD students in European Universities, R1 & R2	Self-assessment of 38 soft skills required for success in the labour market (academic and non-academic careers)	Near completion
Targeted interviews	45 Academia level stakeholders, Vice- Deans and Rectors	Receive qualitative inputs from academia stakeholders on current soft-skills' levels across PhD students, training provision, and current challenges	**Complete**
Targeted interviews	Industry and third sector stakeholders	Understand employee perceptions on any mismatches between soft skills' and market demands	**In progress**
Web scraping	Analyse over 25,000 job postings that require or favour a PhD degree	Understand current labour market requirements in terms of soft skills, understand differences across sectors	**In progress**

The predictive study will be finalized in June 2024. EY requested a 6-month extension, from the original due date in December 2023, in order to have more time to conduct data collection activities across a wider sample.

Survey Results: Research Comp Framework

ResearchComp is made up of two main dimensions: **7 competence areas and 38 competences** that make up the building blocks of the key competences for researchers' careers. The competences used in the Framework derive from the list of transversal skills linked to researchers' occupations that were identified in the context of the update of the ESCO classification

MANAGING RESEARCH TOOLS: 1. Manage research data – 2. Promote citizen science – 3. Manage intellectual property – 4. Operate open-source software

MAKING IMPACT: 1. Participate in publication process – 2. Disseminate results to the research community – 3. Teach in academic or vocation community – 4. Communicate to the broad public – 5. Increase impact of science on policy & society – 6. Promote open innovation - 7. Promote the transfer of knowledge

WORKING WITH OTHERS: 1. Interact professionally – 2. Develop networks – 3. Work in teams – 4. Ensure wellbeing at work – 5. Build mentor – mentee relationships 6. Promote inclusion & diversity

SELF–MANAGEMENT: 1. Manage personal professional development – 2. Show entrepreneurial spirit – 3. Plan self-organization – 4. Cope with pressure

COGNITIVE ABILITIES: 1. Abstract thinking – 2. Critical thinking – 3. Analytical thinking – 4. Strategic thinking – 5. Systemic thinking – 6. Problem Solving – 7. Creativity

DOING RESEARCH: 1. Have disciplinary expertise – 2. Perform scientific research – 3. Conduct interdisciplinary research – 4. Write scientific documents – 5. Apply research ethics and integrity principles

MANAGING RESEARCH: 1. Mobilise resources – 2. Manage projects – 3. Negotiate – 4. Evaluate research – 5. Promote open access publications

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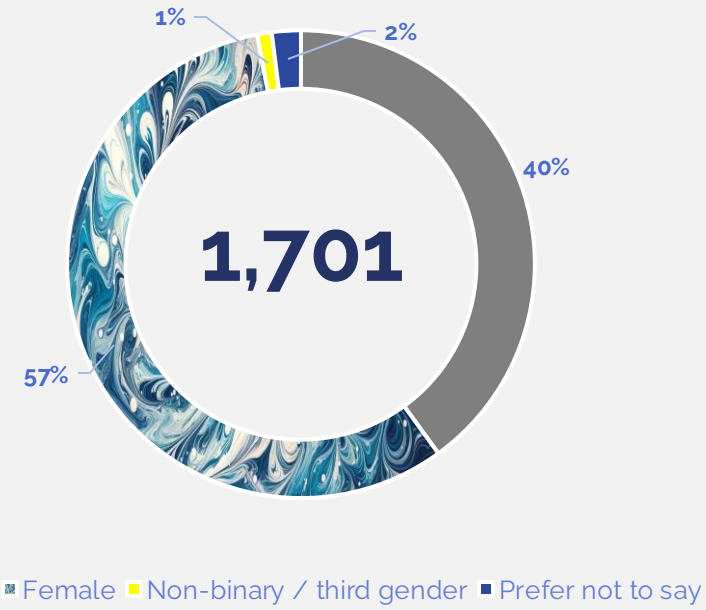
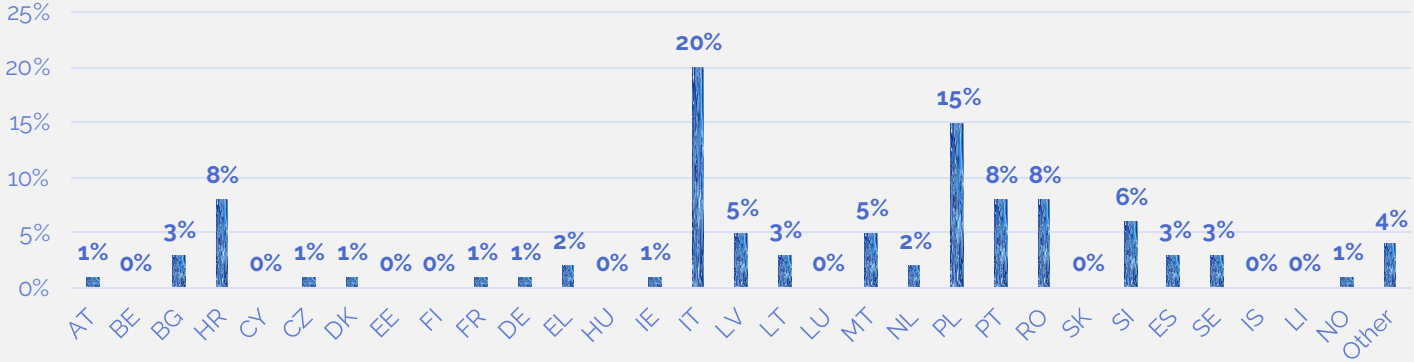
Task 3.3 – Predictive Study - Survey Results: Demographic overview

The survey, reached over **1,700** respondents from over 40 universities. The **gender distribution** is notably skewed towards women. Specifically, 57% of participants identified as female, 40% as male, 1% as non-binary/third gender, and 2% preferred not to specify their gender.



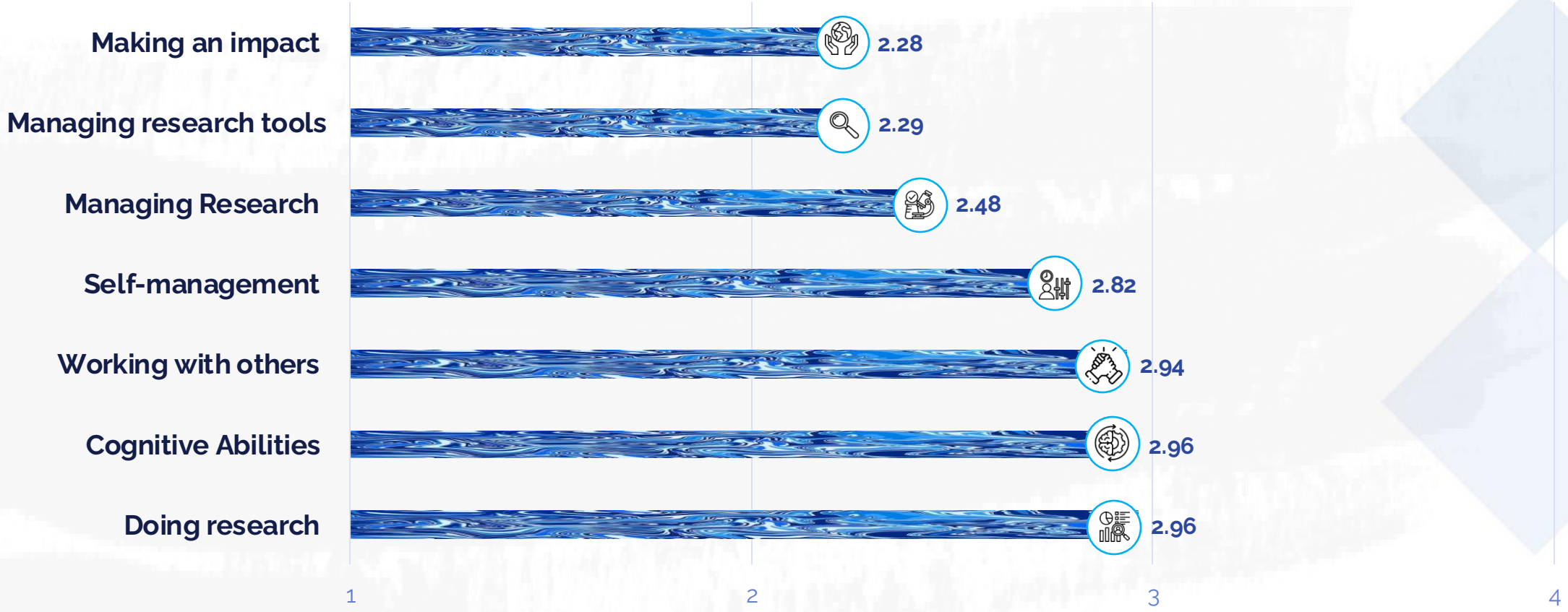
The survey covers **21 EU countries**, with Italy showing the highest engagement at 20%, followed by Poland at 15%. Southern European countries like Italy and Portugal and Eastern European countries such as Poland, Latvia, and Romania demonstrate higher participation rates, indicating regional differences in survey engagement.



Engineering and Technology is the most represented field at 26%, followed closely by Social Sciences at 23%. Natural Sciences are also significantly represented with 22% of respondents. Humanities and Medical and Health Sciences have a moderate presence, accounting for 11% and 10% respectively. Additionally, 7% of participants are involved in other diverse research fields.

Task 3.3 – Predictive Study - Survey Results: Consolidated Self-Rating Scores Across Key Competencies

The survey results represent self-assessment scores by PhD students on various research competencies, with a scale from 1 (lowest) to 4 (highest). "**Doing research**" received the highest score at 2.96, indicating a strong self-perceived competence, while "**Making an impact**" had the lowest score at 2.28, suggesting an area where PhD students feel they need improvement.



Survey Results: Research Comp list of skills

- Abstract Thinking
- Analytical Thinking
- Apply research ethics and integrity principles
- Building mentor-mentee relationships
- Communicate to the broad public
- Conduct interdisciplinary research
- Coping with Pressure
- Creativity
- Critical Thinking
- Develop networks
- Disciplinary expertise
- Disseminate results to the research community
- Ensure wellbeing at work
- Evaluate research
- Increase the impact of science on policy and society
- Interact professionally
- Manage intellectual property rights
- Manage open-source software
- Manage projects
- Managing Personal Professional Development
- Managing research data
- Mobilize resources
- Negotiate
- Participate in publication process
- Perform scientific research
- Planning and Self-Organization
- Problem Solving
- Promote citizen science
- Promote inclusion & diversity
- Promote open access publishing
- Promote open innovation
- Promote the transfer of knowledge
- Showing Entrepreneurial Spirit
- Strategic Thinking
- Systemic Thinking
- Teach in academic or vocational contexts
- Work in teams
- Write research documents

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Task 3.3 – Predictive Study - Survey Results: Self-Rating Scores Across Skills

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LOW FOUNDATIONAL	
• Promote citizen science	**1,91**
• Increase the impact of science on policy and society	**1,62**

INTERMEDIATE	
• Participate in publication process	**2,40**
• Promote open access publishing	**2,35**
• Manage intellectual property rights	**2,33**
• Manage projects	**2,30**
• Manage open source software	**2,18**
• Promote the transfer of knowledge	**2,14**
• Promote open innovation	**2,13**
• Mobilize resources	**2,06**

ADVANCED	
• Perform scientific research	**2,99**
• Problem Solving	**2,98**
• Evaluate research	**2,96**
• Creativity	**2,96**
• Managing Personal Professional Development	**2,92**
• Showing Entrepreneurial Spirit	**2,88**
• Write research documents	**2,84**
• Ensure wellbeing at work	**2,78**
• Strategic Thinking	**2,76**
• Planning and Self-Organization	**2,76**
• Negotiate	**2,73**
• Managing research data	**2,72**
• Coping with Pressure	**2,72**
• Promote inclusion & diversity	**2,72**
• Conduct interdisciplinary research	**2,68**
• Building mentor-mentee relationships	**2,68**
• Systemic Thinking	**2,65**
• Communicate to the broad public	**2,64**
• Disseminate results to the research community	**2,58**
• Teach in academic or vocational contexts	**2,50**

ADVANCED - EXPERT	
• Interact professionally	**3,27**
• Apply research ethics and integrity principles	**3,25**
• Abstract Thinking	**3,18**
• Critical Thinking	**3,11**
• Develop networks	**3,09**
• Work in teams	**3,09**
• Analytical Thinking	**3,09**
• Disciplinary expertise	**3,07**

Task 3.3 – Predictive Study – Skills clustering (dendogram) based on suvey results

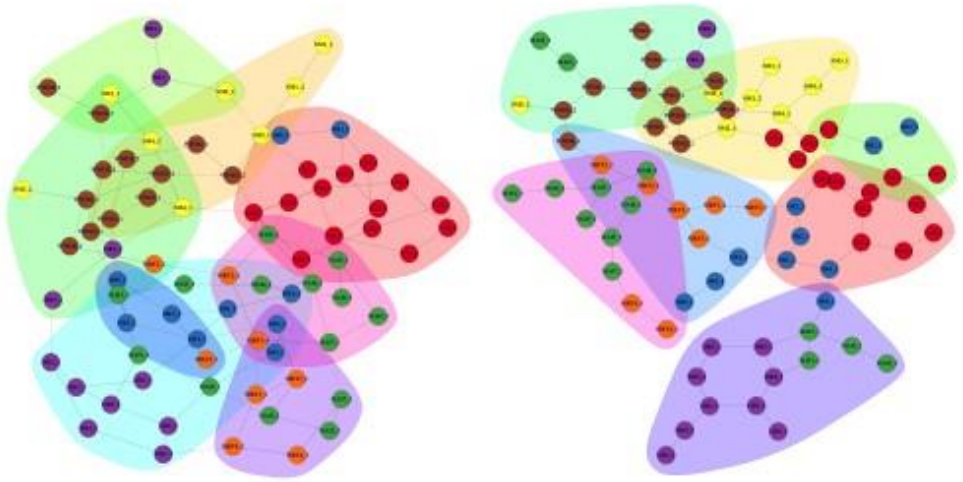
Among the three structures, the graph generated with probabilities greater than 99% appears to yield the most interpretable cluster formations. Upon closer examination of this graph, it becomes evident that the clusters can assist in determining the preassigned categories.

Modularity score:

$$Q = \frac{1}{2m} \sum_{ij} \left(A_{ij} - \frac{k_i k_j}{2m} \right) \delta(c_i, c_j) \tag{9}$$

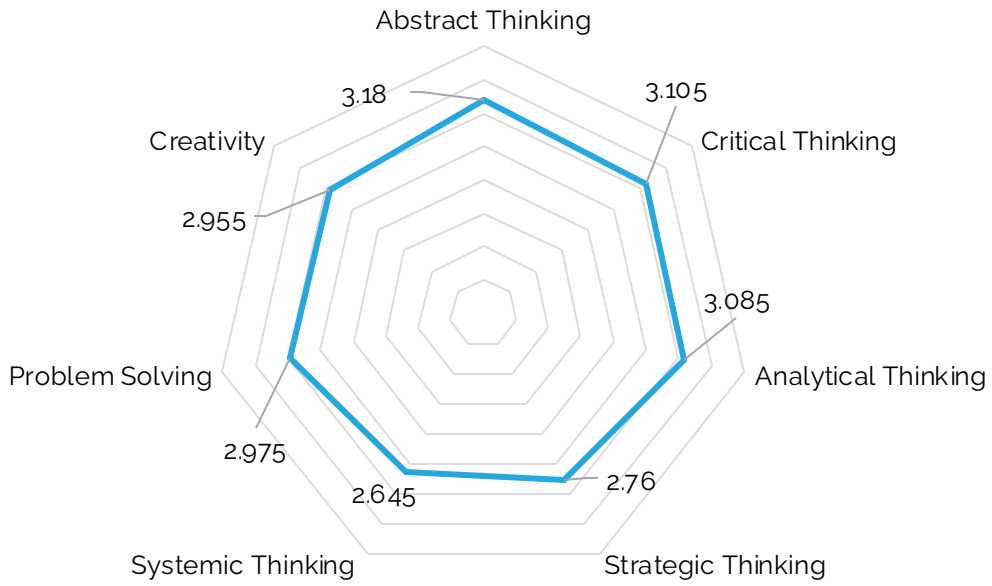
where:

- A_{ij} represents the connection between nodes i and j in the adjacency matrix.
- k_i and k_j denote the degrees of nodes i and j respectively.
- m signifies the total number of edges in the network.
- $\delta(c_i, c_j)$ is the Kronecker delta function, equal to 1 if nodes i and j are in the same community (cluster), and 0 otherwise.

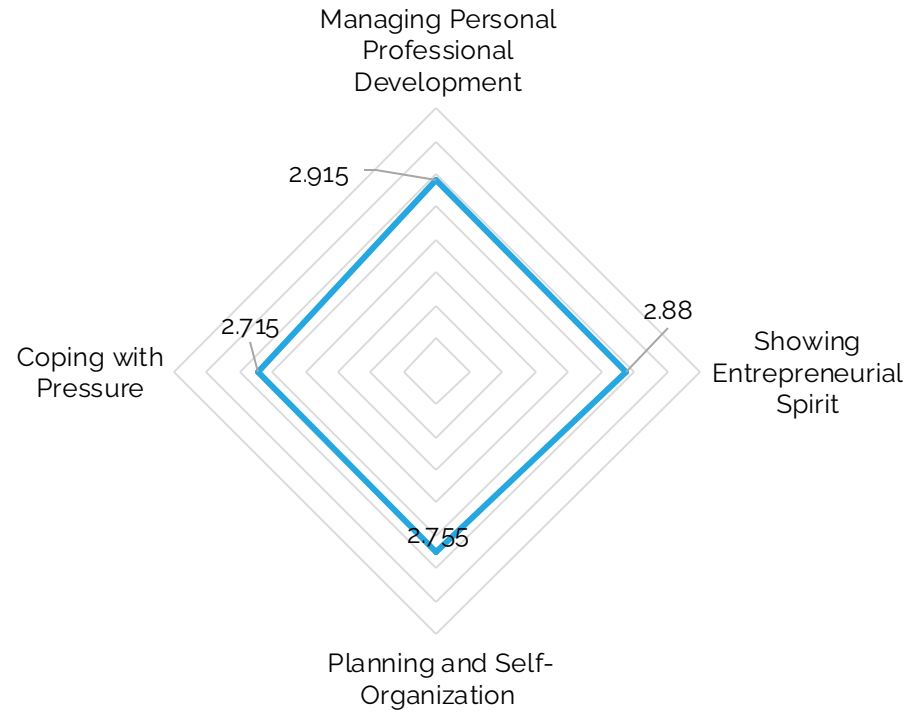


Survey Results: Key competence breakdown

Cognitive Abilities



Self-management



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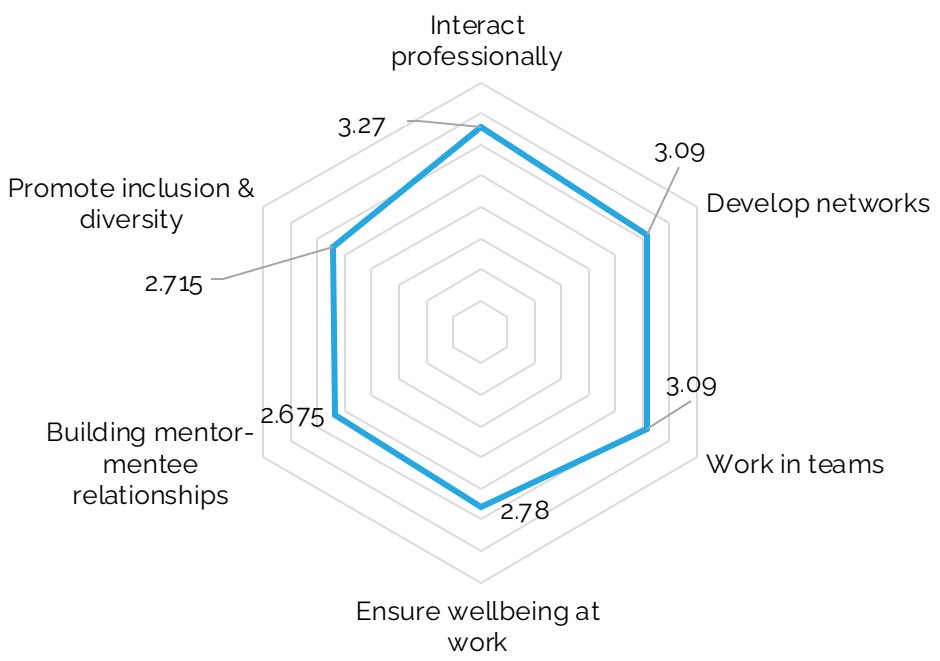
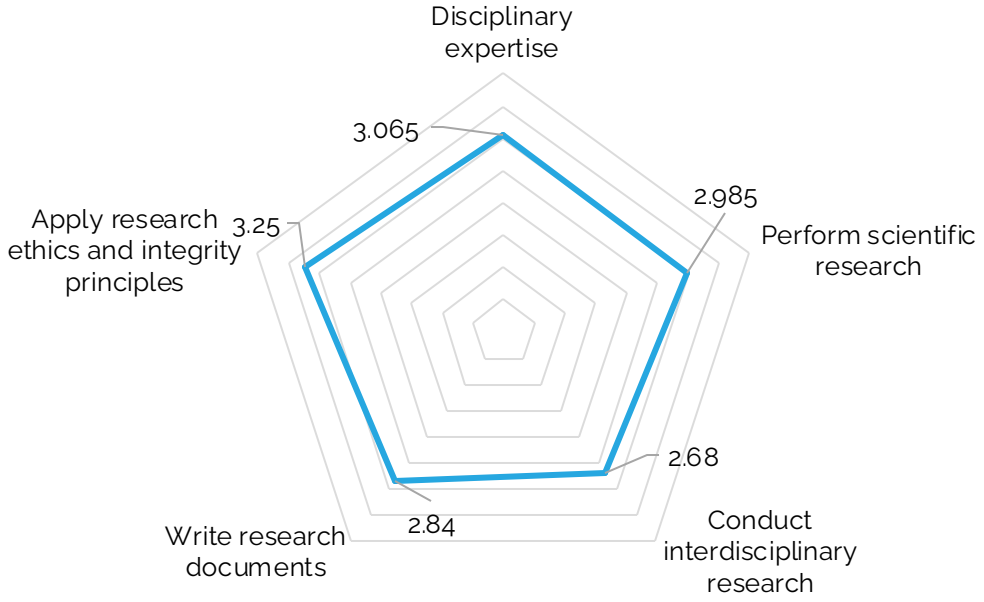
Survey Results: Key competence breakdown

Working with others

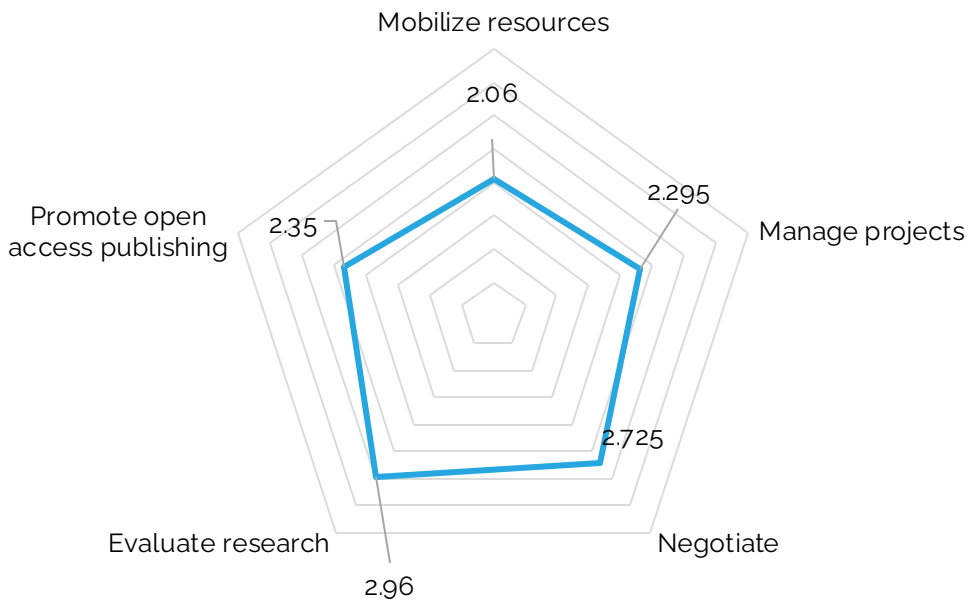


Doing research

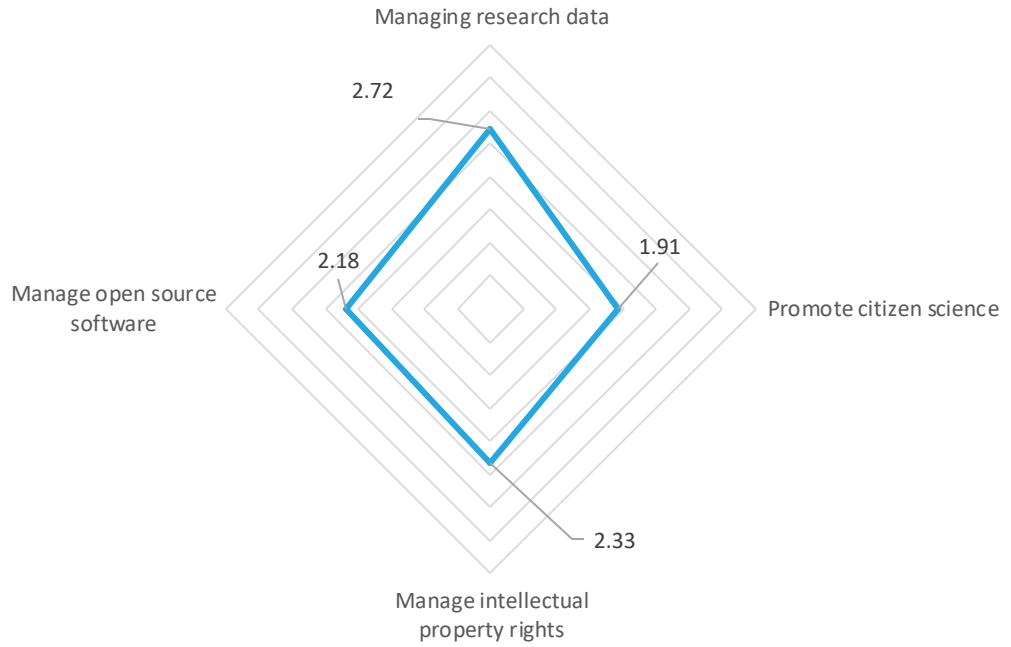


Survey Results: Key competence breakdown

Managing research



Managing research tools



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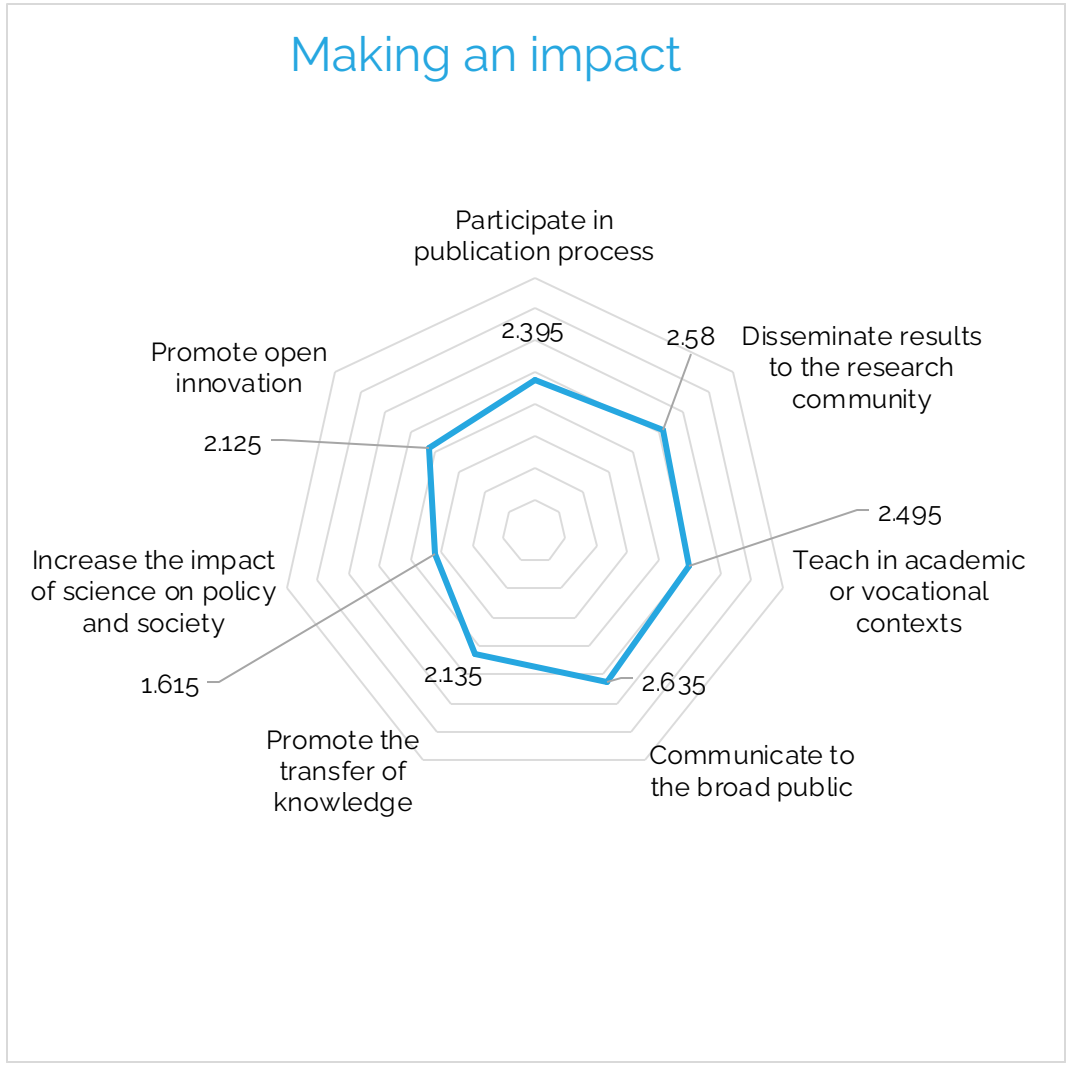
Survey Results: Key competence breakdown



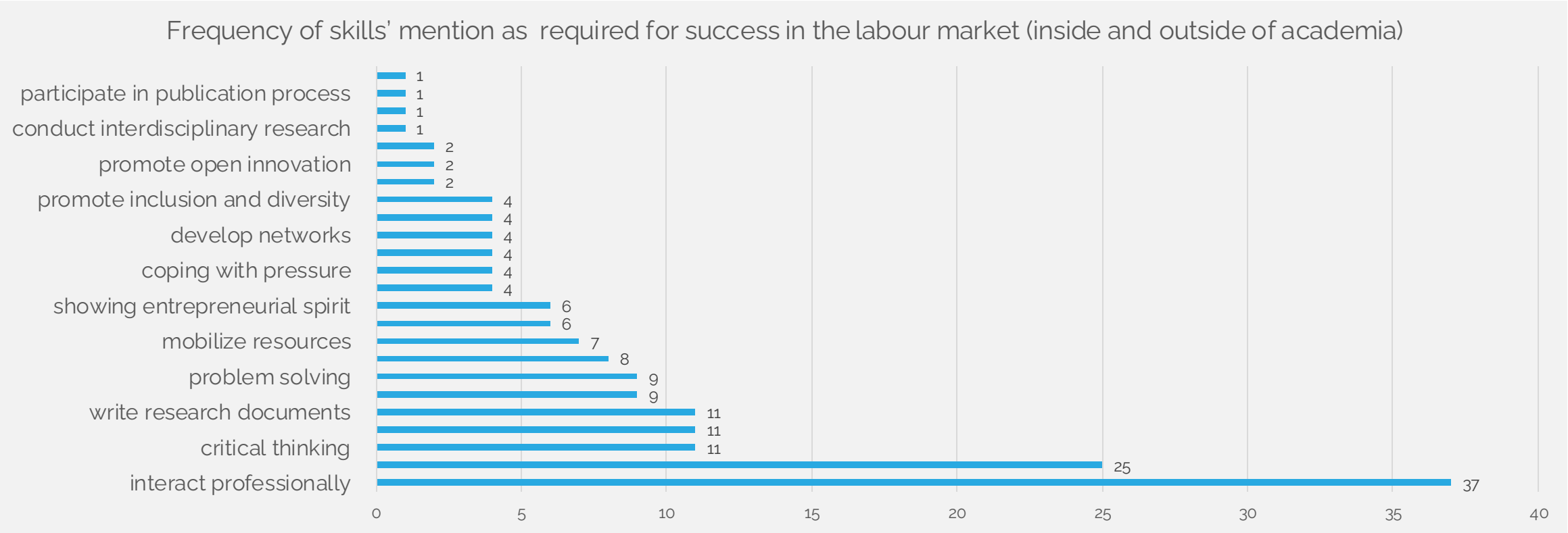
Targeted Interviews with Academia: Preliminary Key insights

To ensure the effective integration of soft skills in PhD programs and to guarantee that graduates possess these skills, higher education institutions are adopting five strategic approaches:

1. **Integrating Soft Skills into Curricula**: Mandatory inclusion of soft skills training in the curriculum, facilitated through courses, workshops, and seminars, ensures comprehensive skill development.
2. **Emphasizing Practical Application**: Institutions provide real-world experiences and placements to allow students to practice and hone their soft skills in professional settings. "We offer training on how to write requests for grants...and how to conduct an interview."
3. **Evaluating and Reinforcing Skills**: Through systematic assessment and feedback from supervisors, along with follow-up surveys post-graduation, institutions evaluate and reinforce the development of soft skills. "Soft skills are already part of our evaluation systems where also supervisors play a key role in evaluating."
4. **Leveraging Interdisciplinary Approaches**: Collaborative and interdisciplinary projects enhance communication, teamwork, and adaptability, preparing students for diverse work environments. "If you are working with other peers, even on something purely technical, at the same time you are developing soft skills."
5. **Innovating Teaching Methods**: Creative and engaging teaching interventions, like simulations and challenge-based education. "By using creative rather than didactic interventions... It disturbs hierarchies."

Task 3.3 – Predictive Study – Qualitative insights from academia targeted interviews

- The analysis **employs natural language processing (NLP)** techniques using R software's NLP packages.
- Text pre-processing involves **normalization** (cleaning and consistency) and **tokenization** (splitting text into words).
- Words related to soft skills are identified, recoded for consistency, and tagged as "skill".
- These tagged words are then categorized into skill classes and analyzed for frequency to assess the importance of various skills.



Moving from as-is to prediction

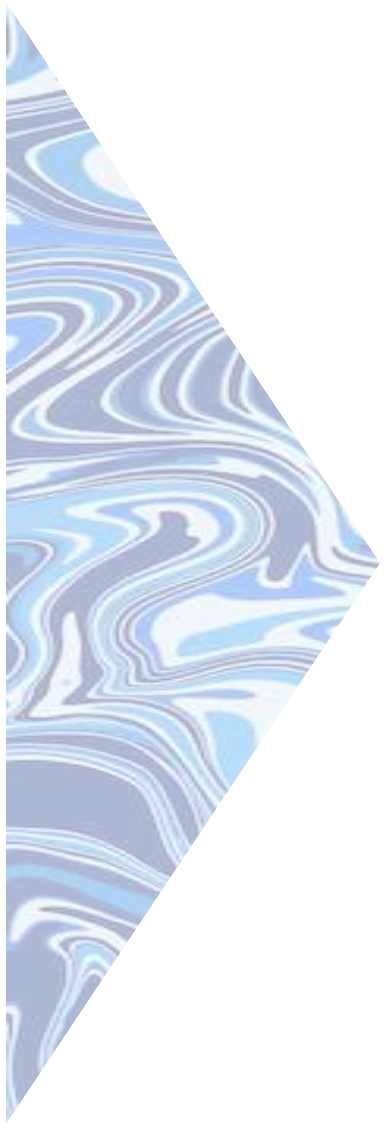
Labour market supply analysis: Self-assessment survey of adaptive and soft skills possessed by PhD students (R1 and R2). **2,000+** respondents

Targeted interviews with academia, industry, and third-sector stakeholders: to collect qualitative insights on labour market supply and demand

Desk research: Previous research on soft skills, and existing gaps

Labour market demand analysis: webscraping of **25,000+** job postings to extract required soft skills across all labour market sectors

MEGATRENDS*
Accelerating technological change and hyperconnectivity
Aggravating resource scarcity
Changing nature of work
Changing security paradigm
Climate change and environmental degradation
Continuing urbanisation
Diversification of education and learning
Widening inequalities
Expanding influence of East and South
Growing consumption
Increasing demographic imbalances
Increasing influence of new governing systems
Increasing significance of migration
Shifting health challenges



Data is fed into machine learning model, co-deveoped by EY, University of Oxford and Pearson.

- **CRISP-ML (Q) & DevOps** machine learning models

*Megatrends are extracted from the EC Competence Centre on Foresight

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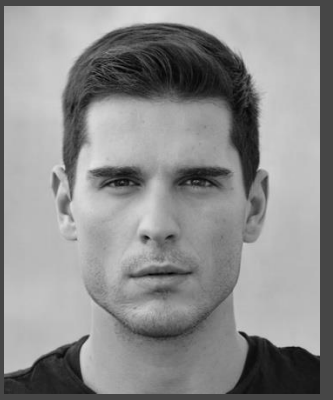
Questions and feedback

Rrap Kryeziu

Senior Consultant



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