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DOCTORAL EDUCATION IN TRANSITION: ADDRESSING CHALLENGES FOR INSPIRING CHANGE

EDUCAÇÃO DOUTORAL EM TRANSIÇÃO: ENFRENTAR DESAFIOS PARA GERAR MUDANÇAS

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INDEX

DOCTORAL EDUCATION IN TRANSITION:
ADDRESSING CHALLENGES FOR INSPIRING CHANGE[1]

João Guerreiro[2]

I would like to begin by thanking all participants for your interest in this reflection, organised by A3ES, on doctoral education models. I am particularly grateful to our guest speakers, who have generously agreed to contribute with their ideas and proposals regarding the future of doctoral programmes.

As we know, this topic has attracted significant attention across various higher education systems worldwide. In Portugal, the subject has engaged Higher Education Institutions, the Foundation for Science and Technology, and, naturally, our Agency.

The growing interest in doctoral education can be largely attributed to the increasing societal need to generate knowledge, a critical driver of development and a resource progressively integrated into human activities. Traditionally, doctoral studies were perceived merely as an academic milestone. This perspective was formalized during the Bologna Process, which incorporated doctoral programmes into its education cycle reforms.

Today, knowledge generation is viewed as a strategic asset for knowledge-based societies. Within this framework, doctoral programmes serve a dual purpose: they produce new knowledge, often with direct applications, while simultaneously equipping doctoral candidates with advanced skills for meaningful societal engagement and individual development.

This perspective elevates doctoral programmes to a strategic priority. Higher Education Institutions should structure these programmes to align with their developmental strategies and specialization profiles. Doctoral programmes, as processes of knowledge creation, fulfil this role by fostering technological, social, or humanistic talents. Some initiatives focus on immediate applications, while others open new pathways for science, humanities, and the arts.

In Portugal, interest in doctoral studies has increased significantly since the 2023 Parliamentary decision allowing polytechnic institutes to award doctoral degrees. Similarly, across Europe, Universities of Applied Sciences, equivalent to our polytechnic institutes, are restructuring their frameworks to offer doctoral programmes.

Despite this progress, the number of doctoral graduates in Portugal has remained steady at approximately 2,500 per year over the past decade, with minor variations of less than 10%. This stability reflects systemic challenges. Higher Education Institutions face difficulties absorbing a significant number of doctoral graduates, as academic roles have become saturated. Simultaneously, the small size of most Portuguese businesses limits their ability to hire PhD holders. This scenario is confirmed by the European Innovation

1 > Opening session speech of the Conference - ***Doctoral Education in Transition: addressing Challenges for inspiring change***, Lisboa, Teatro Thalia, 29 de novembro de 2024.

2 > President of the Management Board of the Agency for Assessment and Accreditation of Higher Education - A3ES, Portugal.

Scoreboard[3], which highlighted in 2020 and 2024 the decline of innovative SMEs and limited investment in innovation-driven employment in Portugal.

The associative sector is widely recognized as having limited potential.

The public sector has recently begun addressing these challenges by hiring doctoral graduates and offering higher salaries to those with such qualifications.

However, the overall absorption capacity remains constrained, despite the growing role of spin-offs and start-ups from research centres and large companies in moderating these limitations.

This session will feature examples of large companies with positive experiences in hiring doctoral graduates. While promising, these initiatives remain limited in scope.

In terms of accreditation, the Portuguese context is unique. Our Agency is responsible for accrediting all doctoral programmes in Portugal, following the respective assessment procedure.

Accreditation of doctoral programmes depends on the research intensity of faculty and researchers affiliated with highly rated Research Centres (Very Good or Excellent classifications). However, this research intensity is assessed by a separate entity (FCT) with distinct work dynamics than A3ES. This dependency raises obstacles and constraints, which normally result in delays. Consequently, the accreditation of some doctoral programmes often takes years after the initial proposal.

Thus, this critical perspective reflects the strategies of both singular programmes offered by individual institutions and those organised by institutional consortia.

Currently, Portugal offers around 600 doctoral programmes. A strategic reorganisation of these programmes may provide solutions for increasing the number of graduates.

However, a positive trend is noticeable, which relates to the growing creation of joint doctoral programmes. Approximately 12% of accredited programmes now involve multiple Higher Education Institutions, primarily in fields like physics, chemistry, mathematics, social sciences, and humanities. There is vast potential to expand joint programmes, particularly in engineering and health sciences. This potential must and should be explored.

The establishment of "European Universities" under the Erasmus+ programme has also created opportunities for international joint doctoral programmes. Several Portuguese institutions are now part of 25 European Universities, opening significant prospects for the future. While still limited in number, the adoption of the European Approach by our Agency will facilitate the development of such programmes, as we are prepared to recognise evaluations conducted by European Agencies compliant with ENQA and EQAR standards.

Considering these factors, increasing the number of doctoral graduates between 2025 and 2030 is crucial. Portugal has made a consistent path in this direction, with outcomes comparable to similar other European countries.

3 > European Commission (2020, 2024), *European Innovation Scoreboard 2020*, Publications Office of the European Union, 2020/2024

The evolution of the share of international doctoral students also demonstrates this progress:

FIGURE 1 – Evolution of the share of international or foreign students in doctoral studies or equivalent (%)

COUNTRIES	YEARS	
	2013	2022
CZECHIA	13	26
ESTONIA	7	32
LATVIA	6	13
LITHUANIA	3	10
PORTUGAL	15	33
SLOVENIA	8	22

Source: OECD (2024), ***Education at a Glance 2024***, OECD Publishing, Paris

This progress and the challenges it highlights motivated us to organise this conference on the future of doctoral programmes.

The opening session will address these future challenges, with Aleksandra Kanjuo Mrcela, chair of Steering Committee of the Council for Doctoral Education, under the European University Association, sharing insights from recent discussions within this Council.

In the evaluation processes of the various study programmes, regardless of the degree, the Agency has paid particular attention to pedagogical issues. In the most recent institutional evaluation, this matter was analysed, and many institutions benefited from suggestions aimed at improving their practices in the future.

In the case of doctoral programmes, this issue is particularly critical. The supervision and guidance of doctoral candidates have often followed an inconsistent path, frequently due to a lack of clear criteria from supervisors. There is also some misunderstanding regarding the role of the supervisor/tutor, although significant differences are observed in the approaches across different scientific fields. This topic needs further reflection. Considering the quality of supervision and progress monitoring in doctoral education paths, we've challenged Professor Peter Hanenberg to explore these themes.

We believe that, in the near future, Higher Education Institutions will not overlook this issue, as the failure rate in doctoral programmes is largely influenced by how these programmes are structured, how interim milestones for progress reporting are organised, how complementary internships are promoted, and how the attendance of seminars on complementary topics, particularly those related to transversal skills, social

content, or humanities, is encouraged. Institutional culture should include conditions that favour research, provide an environment conducive to reflection, create mechanisms for protecting innovations, and, in some cases, ensure resources for experimentation. These elements are core for a future framework of doctoral programmes.

The conference will follow with a keynote from the European Commission's Director of Higher Education Policy, who will discuss the integration of national systems and the future of the European degree under the Bologna Process.

We must acknowledge that the European Commission has been paying increasing attention to global strategies for higher education, with a focus on integrating national higher education systems. The Bologna Process facilitated the recognition of study programme structures, simplified student mobility, promoted the creation of joint offerings, introduced increasingly standardised evaluation criteria, and explored the conditions under which the European label and degree could be awarded.

The 'European Universities' initiative, already mentioned, seems to be a fundamental step in fostering a collaborative environment. It facilitates the exchange of academic community members, the implementation of joint projects, the accreditation of joint programmes, and provides an intense scientific dialogue that fosters creativity and drives innovation.

Students' voices must also be heard. Thus, a session dedicated to the perspectives of doctoral students is in place. It will feature two representatives. Nora, an organic chemistry doctoral student, is a member of the European Students' Union and leads a Task Force dedicated to exploring and advocating doctoral candidates' needs. Margarida, a sociology doctoral candidate in Portugal, will share insights into the challenges faced by Portuguese doctoral students, as research units' integration, funding, supervision and training.

Despite the somewhat unfriendly environment in the business world for integrating doctoral graduates, there are good examples, particularly from large technology companies, as well as from spin-offs and start-ups. These are the two sectors competing to attract doctoral graduates, especially those from technological fields.

The conference will continue with a roundtable, moderated by Manuel Heitor, former Minister of Science, Technology and Higher Education, which will address the experiences of two large companies, a Technology Development and Transfer Centre, and a collaboration project between American and Portuguese universities, under which a significant number of doctoral programmes have been developed.

These are compelling examples that signal promising forms for collaboration between universities and businesses, particularly in the technological fields. However, areas such as management, services, health, agricultural sciences, arts, and humanities still face significant challenges in terms of professional integration.

Recently, the Foundation for Science and Technology launched a competition for doctoral scholarships in non-academic settings. Of the 1,500 scholarships offered, only 30% were awarded to non-academic institutions. Higher Education Institutions remain the primary entities absorbing doctoral graduates, particularly for activities related to laboratory support, academic services, and international cooperation.

The companies invited to the roundtable have extensive experience integrating doctoral graduates into their activities. It is expected that the main themes of the doctoral processes—ranging from supervision to employability, from selection to the outcomes—will be analysed from various perspectives.

The conference programme also includes a session with the participation of representative entities from Portuguese Higher Education Institutions: the Portuguese Association of Private Higher Education (APESP), the Coordinating Council of Polytechnic Institutes (CCISP), and the Council of Rectors of Portuguese Universities (CRUP). These entities will address the realities of doctoral programmes in their respective sectors.

The conference will conclude with a closing address by Professor Ana Paiva, Secretary of State for Science, highlighting the government's commitment to advancing doctoral education as a driver of knowledge production and societal development.

Again, thank you very much for your presence. I wish you all a pleasant conference and healthy discussions. I hope this conference proves to be productive and that the discussions provide valuable insights for the future of doctoral education.

STRUCTURING DOCTORAL EDUCATION: CURRENT TRENDS AND CHALLENGES AHEAD

Aleksandra Kanjuo Mrčela[4]

INTRODUCTION

This contribution is based on a lecture given at the A3ES International Conference in Lisbon on 29 November 2024. It was a particular pleasure to deliver a lecture on doctoral education in Portugal, a country with a long tradition of valuing knowledge and education. Shortly before my visit to Lisbon, I read an engaging account centred on the University of Coimbra, one of the oldest universities in Europe and a symbol of the nation's dedication to learning and intellectual development. Originally founded in Lisbon in 1290, the university relocated to Coimbra in 1537. Over the centuries, it has been a cradle of Portuguese intellectual life, producing scholars, poets and thinkers who have influenced not only Portugal, but also the wider world. The university has witnessed and withstood many historical changes and challenges, including periods of political turbulence, censorship and reform. Despite these obstacles, the institution has endured, symbolising the resilience of knowledge and the importance of education in advancing society. In the 18th century, Marquês de Pombal, a prominent reformer, transformed the university as part of his broader efforts to modernise Portugal. Following the devastating 1755 Lisbon earthquake, Pombal sought to rebuild and strengthen the country, recognising the university's role in producing the intellectual capital necessary for this endeavour. This emphasis on scientific knowledge was a revolutionary step for Portugal, bringing the country into line with contemporary European developments and highlighting the transformative power of education in national renewal.

Drawing on the experiences of Portugal and other European countries in terms of the transformative value of knowledge, this contribution presents some of the changes and accomplishments in the structuring of doctoral education over the last few decades, and discusses the evolving developments and challenges ahead. I aim to provide an overview of the key points regarding the structuring of doctoral education, touching on challenges, opportunities and future directions, all with the aim of improving knowledge production — the crucial capital to which universities are committed.

This contribution is being made at a time when we are celebrating the 20th anniversary of the Salzburg Principles – a key milestone in the transformation of doctoral education in Europe. Adopted in 2005 as part of the Bologna Process, the Salzburg Principles established a shared vision for structured doctoral education in Europe. They are focused on supporting an increased number of doctoral candidates as they prepare for careers within and beyond academia, thereby creating and disseminating knowledge to benefit society. Doctoral education in Europe has undergone profound changes since Salzburg principles were published. We see an increasing institutionalisation of doctoral education and various ways of strengthening its quality, including improved supervisory practices, expanded training in transferable skills, enhanced career support and increased international cooperation. The developments observed reflect a strong alignment with the original aspirations of the Salzburg Principles. Across Europe,

4 > University of Ljubljana, Chair of the Steering Committee, EUA Council for Doctoral Education (EUA-CDE)

universities have embraced these goals and implemented significant reforms that foster a more supportive and responsive environment for researchers at the beginning of their careers[5]. However as every process of change, the structuration of doctoral education has its challenges, that we will also address.

The processes we are discussing go beyond just structural alterations; the changes at European universities show the emergence of a new culture of doctoral education - one of shared responsibility and continuous adaptation to the evolving needs of research and society. It reflects not only how universities are responding to challenges, but also how they are actively shaping the future of European research and higher education. These changes are taking place in a wider context of geopolitical uncertainty, economic instability and social fragmentation. In such precarious times, it is more important than ever to build a society based on knowledge, critical thinking and innovation. Universities have a crucial responsibility in this regard, and investing in doctoral training means investing in Europe's capacity to respond to current and future challenges.

DOCTORAL EDUCATION IN EUROPE: TWENTY YEARS OF STRENGHTENING STRUCTURES

In doctoral education, the concept of structuration refers to the transition from the classical Humboldtian model, which was centred on one-to-one mentorship, to more structured programmes that incorporate multiple supervisors and promote interdisciplinarity, intersectorality and internationalism. This shift has largely been driven by the universities themselves, with national legislation providing broad frameworks and innovation stemming from institutional initiatives. Today, doctoral schools and structured programmes dominate across Europe. Almost 95% of European universities have adopted such models. These developments are anchored in the Salzburg Principles (2005), which continue to serve as a guiding framework. Key principles include focusing on original research, integrating doctoral education into institutional strategies, ensuring high-quality supervision and assessment, recognising doctoral candidates as professionals, and supporting the development of transferable and interdisciplinary skills.

5 > The European University Association (EUA) and its Council for Doctoral Education (EUA-CDE) have played a very important role in this evolution. The largest European doctoral education network, the EUA-CDE represents 292 universities from 39 countries. The EUA-CDE promotes cooperation and exchange, identifies trends and acts as a key policy voice for doctoral education across Europe.

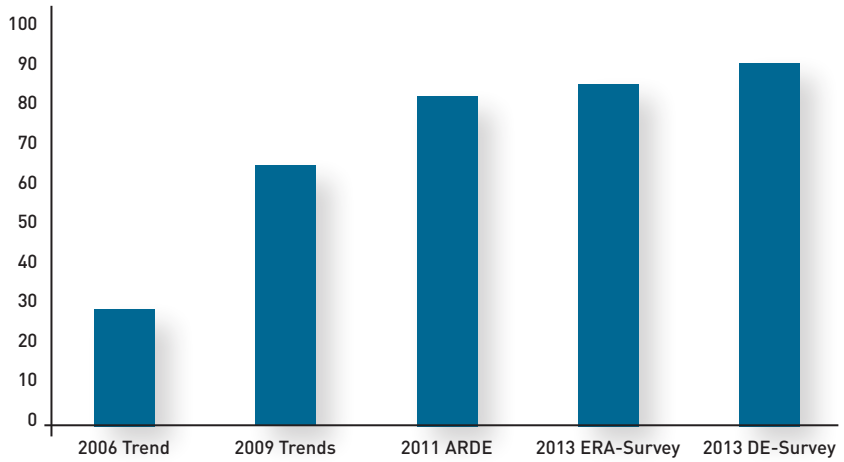
FIGURE 2 – Principles from the Bologna Seminar in Salzburg on "Doctoral Programmes for the European Knowledge Society" February 2005

1. ADVANCEMENT OF KNOWLEDGE THROUGH ORIGINAL RESEARCH
2. EMBEDDING IN INSTITUTIONAL STRATEGIES AND POLICIES
3. THE IMPORTANCE OF DIVERSITY OF DOCTORAL PROGRAMMES
4. DOCTORAL CANDIDATES AS EARLY-STAGE RESEARCHERS SHOULD BE RECOGNISED AS PROFESSIONALS
5. THE CRUCIAL ROLE OF SUPERVISION AND ASSESSEMENT
6. ACHIEVING A CRITICAL MASS
7. DURATION: 3-4 Y YEARS FULL-TIME
8. THE PROMOTION OF INNOVATIVE STRUCTURES WITH INTERDISCIPLINARY TRAINING AND TRANSFERABLE SKILLS
9. INCREASING INTERDISCIPLINARY, INTERSECTORAL, AND INTERNATIONAL MOBILITY IN DOCTORAL PROGRAMMES
10. ENSURING APPROPRIATE FUNDING

Source: Bologna Seminar in Salzburg, February 2005

EUA-CDE (2019) conducted a survey outlining the major changes that have occurred in the organisation of doctoral education in Europe in the decade and a half since the Salzburg Principles were adopted. The survey showed that doctoral schools and programmes are the predominant institutional structures for doctoral education. These structures oversee programme development, ensure quality and develop regulations and guidelines.

FIGURE 3 – Structured doctoral education in Europe: % of universities with doctoral schools



Source: EUA-CDE

Other key points of the survey results included the following:

- Universities have increasingly taken on **institutional responsibility** for early-stage researchers, resulting in the creation of a variety of practices, policies and structures to support doctoral education.

- Doctoral education is primarily organised at the **disciplinary (64%) and faculty (52%) levels**. A smaller percentage (14%) is organised around themes or societal challenges.

- Institutions have implemented **rules and guidelines** for various aspects of doctoral education, such as required courses, the assessment of training activities, course content and credits. This reflects a professionalised approach to managing doctoral education.

- **Supervision has become a well-regulated**, collective effort with guidelines for appointment procedures, reporting, providing feedback and resolving conflicts. Supervisory teams are becoming increasingly common, complementing the role of individual supervisors.

- The **application and admissions process** focuses on evaluating candidates' future research potential through interviews, research proposals and presentations, rather than relying solely on past achievements.

- Internal **quality assurance systems** are widely established, and external evaluations are also common. Indicators such as academic publications, completion rates and staff qualifications are used to evaluate the quality of doctoral education.

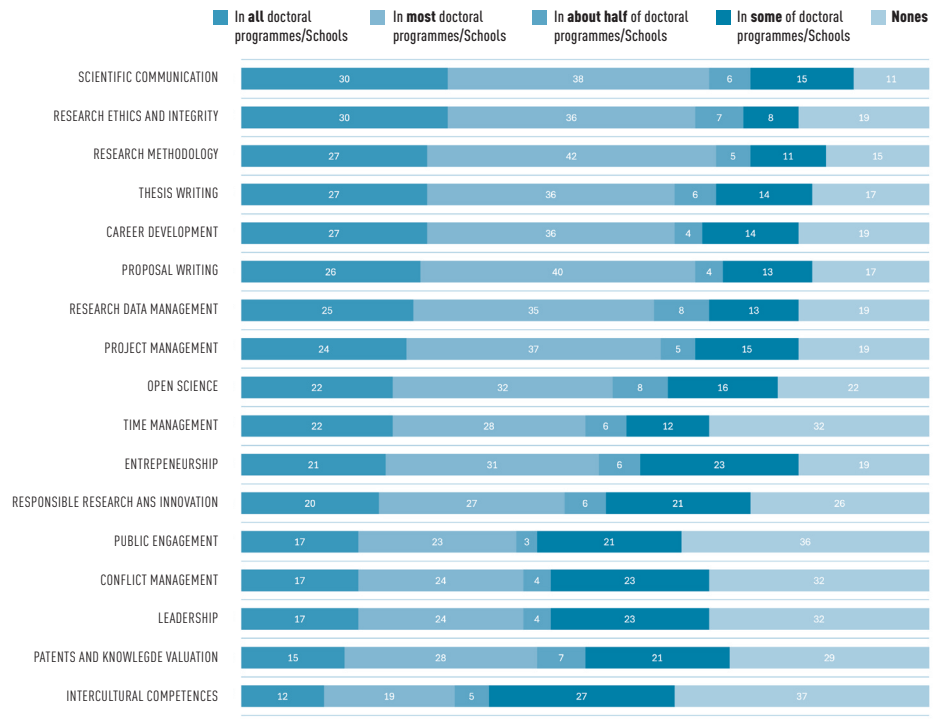
Overall, the organisation of doctoral education reflects a shift towards a more comprehensive and professionalised approach that balances institutional goals with the needs of early-career researchers. Doctoral education in Europe however stays

very diverse. This applies to the level of organisation (doctoral programme/school at faculty/department level or institutional structure), duration, credit points, degree of flexibility, funding of the doctoral school, funding of doctoral students, status of doctoral candidates, etc.). All of these features are based on a common agreement that "the core component of doctoral training is the advancement of knowledge through original research" and that it must also prepare students for employment outside of academia. Universities' prioritising the employability of doctoral candidates outside academia, align doctoral education with the needs of society at large, including the business sector, civil society and public institutions.

There remains some variety as to how doctoral schools are embedded in university structures and the extent to which they have a disciplinary focus. They are staffed by an emergent **professional group, whose specialisation has a clear focus on doctoral education.**

The EUA-CDE (2022) survey showed increasing trend of institutional responsibility and support to doctoral candidates by offer of transversal skills training. Only a minority of transversal skills trainings are mandatory – doctoral candidates need to be able to choose which one fits them well.

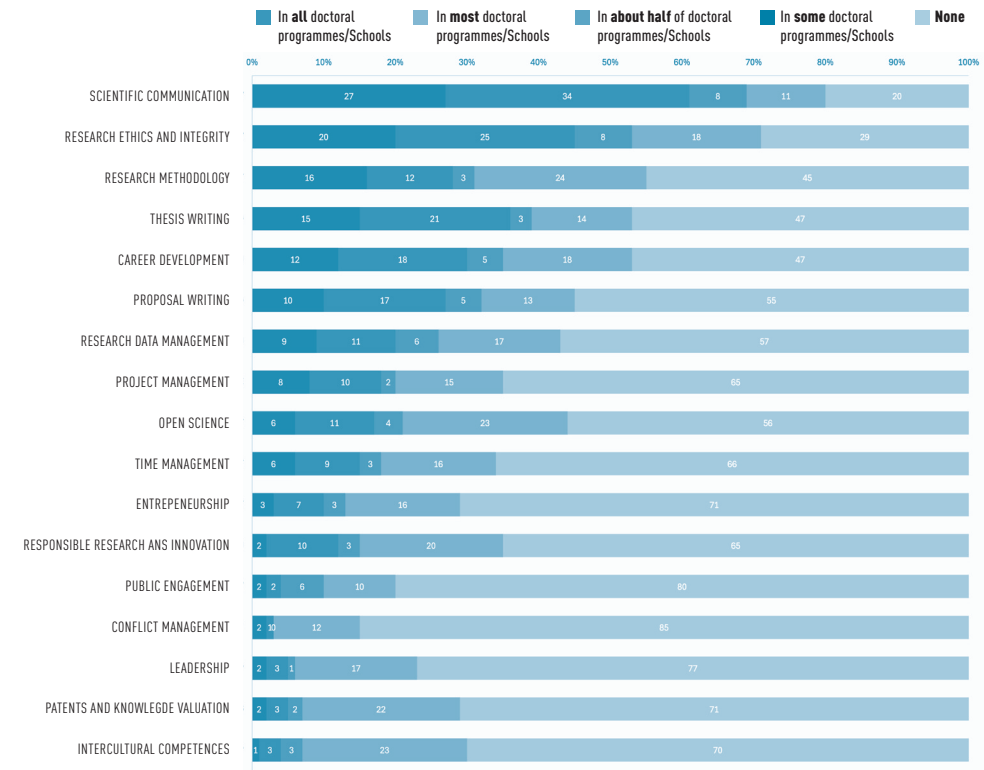
FIGURE 4 – What type of optional transversal skills training is offered to doctoral candidates at your institution?



Source: EUA-CDE,2022a

Exceptions include training in research ethics and integrity, and research methodology, i.e. skills that are considered prerequisites for all types of research.

FIGURE 5 – What type of mandatory transversal skills training is offered to doctoral candidates at your institution?



Source: EUA-CDE,2022a

In addition to doctoral or postgraduate schools being established at many universities to provide centralised support and supervision, as well as introducing formal training components, the new framework has accelerated the formalisation of quality assurance in the supervision and assessment of doctoral candidates' work, and institutional accountability. Doctoral candidates are increasingly seen as early-stage researchers rather than just students, albeit to varying degrees.

The reconfiguration of supervision practices is a key part of the wider organisation of doctoral education. Traditionally, doctoral supervision was characterised by an individualised, apprenticeship-style model centred on a one-to-one relationship between the candidate and a senior academic. This informal, personalised relationship formed the cornerstone of academic socialisation. One of the most notable developments is the shift towards collaborative and distributed supervisory models. Structured programmes now often require supervisory committees or teams to be formed, comprising co-supervisors from the same institution, external academics and non-academic partners such as industry professionals or NGO representatives. Although this team-based approach provides doctoral candidates with access to a broader range of expertise and perspectives, it may reduce the intensity and consistency of the mentorship typically associated with single-supervisor models. Alongside this shift comes the formalisation of supervisory roles and expectations. Many structured programmes now require supervisory agreements or charters, which define the responsibilities of supervisors and candidates alike. These agreements often specify the expected frequency of meetings, the nature and timing of feedback, and mechanisms for resolving conflicts. While these contractual arrangements are designed to enhance transparency and accountability, they may also introduce a more bureaucratic dimension to supervisory relationships. In short, supervision in structured doctoral education has undergone a significant transformation. It has become more collaborative, formalised, and integrated within broader institutional frameworks. While these changes aim to improve the quality, transparency and fairness of doctoral training, they also signal a shift away from the autonomous and personal traditions of academic mentorship towards a model increasingly shaped by institutional accountability, standardisation and professional development.

Current Trends of Changes: Structures and culture of doctoral education

The evolution of the institutional context of doctoral education reflects broader societal and academic changes. One of the most significant developments is digitalisation. Universities are actively integrating digital tools into research training, reshaping practices in areas such as virtual supervision, digital research communication, and data management. The rise of artificial intelligence and other emerging technologies requires doctoral programmes to adapt accordingly. According to the 2021–22 EUCDE survey, 71% of institutions identified digitalisation as a strategic priority, signalling its far-reaching implications for doctoral education in terms of both organisation and content. As artificial intelligence (AI) becomes more prevalent in academia, discussions about its role in supervision are emerging. AI is thus becoming a potential new player in the relationship between doctoral candidates, supervisors and institutions, raising questions about academic guidance, integrity and autonomy. Meanwhile, data management and sharing have become central to research activity. According to recent data, 77% of institutions now provide training in the FAIR data principles (findable, accessible, interoperable, and reusable). Beyond data handling, there is also an increasing focus on equipping candidates with research communication and visualisation skills to enable them to disseminate their findings effectively to academic and non-academic audiences alike. These shifts are closely tied to broader transformations in virtual communication and the expectations placed on doctoral researchers.

While internationalisation has always been a feature of scientific work, opportunities for international cooperation and mobility, as well as joint doctoral programmes (e.g. Erasmus+ and the Marie Skłodowska-Curie Actions), have strengthened, particularly within the EU.

Doctoral candidates are increasingly regarded as not only future scholars, but also as agents of societal transformation. Structured programmes are incorporating new objectives, such as co-creating knowledge with non-academic stakeholders and improving public understanding of science. At the same time, many doctoral programmes are explicitly aligning with global sustainability agendas, emphasising contributions to climate action, social equity, and international cooperation — particularly between partners from the Global North and Global South. Within this evolving context, issues of diversity, equity and inclusion (EDI) have become more prominent.

Institutions are placing greater emphasis on addressing systemic access barriers affecting doctoral participation and completion. Factors such as immigration status, caregiving responsibilities, precarious employment conditions and language diversity are increasingly recognised as shaping the doctoral experience. While significant work remains to ensure meaningful structural change, initiatives aimed at fostering inclusivity are now more widespread. In line with the Salzburg Principles, there is a growing consensus that more institutions must commit to creating environments that enable doctoral research. This includes providing adequate support structures, fostering intellectual autonomy and integrating doctoral education into a broader commitment to research excellence, societal engagement and global responsibility. Structuring doctoral education has brought significant benefits. According to Bernstein et al. (2014), structured programmes incorporating coursework, skills training and cohort-based models have improved completion rates, increased transparency and enhanced support for early-career researchers. Furthermore, the incorporation of transferable skills and career development programmes reflects a wider acknowledgement of the societal value of doctoral graduates, extending beyond academia to government, industry, and civil society.

A key theme that emerges from the literature is the growing institutionalisation of support structures for doctoral candidates. As Deem (2020) argues, discussions about structure must prioritise the mental health and well-being of doctoral researchers. Formalising supervision practices, embedding equity and diversity, and ensuring inclusive research environments are all necessary in order to uphold universities' mission to serve the public good.

Cardoso et al. (2020) provide a thorough overview of the structural and institutional changes currently shaping doctoral education. They highlight the emergence of intersectoral partnerships, digital platforms for supervision and collaboration, and increased stakeholder involvement. However, they also caution against excessive standardisation and bureaucratisation, as these can stifle innovation and flexibility.

Structuring Doctoral Education in a Changing Global Landscape

Over the past two decades, doctoral education has undergone profound changes not only in Europe, but also worldwide. These changes have been driven by globalisation, evolving labour market demands, institutional reforms and changing societal expectations. Structuring doctoral education has emerged as a key strategic and academic priority. A systematic literature review by Cardoso et al. (2022) explored the current landscape of doctoral education structuration, identifying the coexistence of various ideas and concepts of doctoral education, as well as the manifestation of its transformation towards an emphasis on competences and employability enabled by doctoral education. This influences a number of features and aspects of doctoral education, such as recruitment, supervision, institutional structures, diversified doctoral training, and collaboration with the economic sector and labour market. Both Deem (2020) and Nerad (2014) observe how the changing mission of universities and the rise of the knowledge economy have redefined doctoral education as both a process and a product, moving away from the classical Humboldtian research model involving one master professor passing on specialised knowledge and the art of research to one student in one discipline within a hierarchical learning environment. Kehm (2020) highlights the diversification of doctoral programmes across Europe, where reforms have led to the establishment of professional doctorates, joint degrees and industrial collaborations. These innovations reflect the broader goal of aligning doctoral training with societal and economic imperatives while retaining academic rigour. While some of the recent changes in European or Australian contexts, such as selective admission, supervisory teams and structured programmes, were present earlier in North American universities, other changes, such as multidisciplinary doctoral programmes and different types of doctorates, were more recent in North America (Cardoso et al., 2022). When comparing the European and Chinese experiences, Bao et al. (2018) highlight a converging trend towards more process-oriented doctoral education characterised by transparency, quality assurance and training in transferable skills.

Nerad and Heggelund (2011) and Nerad and Trzyna (2008) emphasise the global dimension of doctoral education structuration. Mobility programmes, international collaborations, and global networks have become essential components of doctoral training. However, these developments also raise questions about equity, access and the homogenisation of research cultures.

Based on the research, experiences, and discussions of over 160 education researchers, doctoral education leaders, early career researchers from various disciplines, and funding agency representatives at an international conference in Hanover in September 2019, a group from around the world 'Forces and Forms in Doctoral Education' developed Hannover Reccomendations. The recommendations aimed to improve doctoral education worldwide, facilitate the development of future researchers around the globe and develop a more inclusive and respectful research environment. In line with the Salzburg Principles, the Hannover Recommendations acknowledge that originality of research is at the heart of doctoral education, which develops 'creative, critical, autonomous and responsible intellectual risk-takers'. The Recommendations propose the following seven measures to universities, governments and funders of doctoral education:

1. Establish a global joint value system for doctoral education based on **an ecology of knowledges** which recognises and seeks to overcome existing inequalities in the access to doctoral education and the provision of knowledge.
2. Foster diverse ways of operating – embracing **diversity of cultures, people and universities.**
3. Encourage **diverse forms of mobility** to develop multiple careers and ensure a more balanced distribution of talent around the globe.
4. Ensure that the key contribution of the **Arts, Humanities and Social Sciences** research and doctoral education gets strong support.
5. Support more **research on doctoral education** for evidence-based decision-making on doctoral education around the globe.
6. Advance **the institutional environment** for doctoral education continuously.
7. The pivotal goal of doctoral education must be and remain the development of original, responsible, and ethical thinkers, and the **generation of new and original ideas and knowledge.**

What the Future Holds?

Drawing on the Vision for the Future of Doctoral Education in Europe (EUA-CDE, 2022) and the research presented, we can identify some strategic priorities for future developments in doctoral education.

TABLE 1. WAYS FORWARD

1	Doctoral schools serve as a place where the opportunities and challenges of new digital technologies are embraced in the pursuit of research goals and in their own enabling frameworks.
2	Universities should embrace the Sustainable Development Goals as a holistic framework providing a context for and supporting the delivery of doctoral education.
3	Even when not connected to a specific mission, research and education at doctoral level contributes to the resolution of the environmental, demographic, socio-economic, and political challenges that Europe and the world are facing. The path to resolving these challenges may lie in addressing fundamental research questions where the application is not evident at the time.
4	A diverse doctoral education must be sensitive to the different backgrounds that doctoral candidates bring with them. Doctoral education should encourage reflection on and the overcoming of any social, economic or cultural barriers. It should foster a diversity that goes hand in hand with excellence and a shared understanding of research quality.
5	Doctoral education should promote a dialogue about the different dimensions of academic freedoms and raise awareness about where any are at risk. It should create an open space for critical debate and the exchange of opposite views, while defending the rights of doctoral candidates to engage in these activities.
6	Doctoral education needs to embrace the variety of formats which have emerged to meet specific needs but at the same time to ensure that the core principles, including the importance of conducting original research, remain integral to all of these. Structured approaches should be used as a means of ensuring that the voice of doctoral education is properly embedded in university structures.
7	A fit-for-purpose quality assurance system is essential, but the overarching goal is the quality of research, not the use of a particular tool. The focus should go beyond administrative processes to also value the education and research content. That should include an understanding of core skills and values such as research ethics and integrity and the adoption of a critical approach to research assessment not confined to publication metrics.
8	Doctoral candidates must be equipped with the knowledge and skills to meet the modern demands of research and pursue their chosen career paths. At the same time, they need to map, visualise and verbalise their skills and communicate those capabilities to others. Doctoral education should develop both tacit and explicit skills. Transversal skills should not be seen as an add-on but as a key element of the doctorate, maintaining the essential role of original research as the key feature of doctoral education
9	Supervision is crucial. Its form adapts to the needs and resources of an institution. Universities should invest in the training of supervisors, enabling them to embrace their roles fully and ensure that the doctoral school or environment plays its appropriate supportive role.
10	The level of living support for doctoral candidates needs to take into consideration the relative attractiveness of the careers and the incomes of early-career knowledge workers in other sectors. This means that the work of doctoral candidates should be appropriately rewarded. Duration of funding should be based on a realistic assumption of the duration of a doctorate. An increase in salaries or duration of the doctorate should not, however, be at the expense of the availability of doctoral positions. The increased need to tackle societal challenges with high-quality research demands the availability of such positions, but this should not lead to a reduction in other university

Source: **EUA-CDE, 2022: Vision for the Future of Doctoral Education in Europe**

The statements above deal with the changes and challenges of our times that cannot be overlooked but must be dealt with responsibly. As doctoral education continues to evolve, the structures and cultures that underpin it are facing significant challenges and opportunities. Institutions are increasingly expected to uphold academic excellence and serve as responsive, inclusive, and forward-looking environments. Meeting these demands requires us to reconsider the structure of doctoral education and how its culture is cultivated.

First and foremost, digital transformation is reshaping the foundations of doctoral research and training. Doctoral schools are at the forefront of this shift, embracing the opportunities and challenges posed by new digital technologies. From virtual supervision and collaborative platforms to AI-assisted research processes, digital tools are becoming embedded in the day-to-day practice of doctoral training. These technologies necessitate a recalibration of supporting frameworks to ensure they facilitate research objectives while promoting inclusivity and accessibility. Meanwhile, the Sustainable Development Goals (SDGs) offer a powerful, comprehensive framework for doctoral education. By aligning their missions with these global priorities, universities can establish doctoral education as a vital catalyst for sustainable change. Even when not explicitly focused on mission-oriented research, doctoral projects can contribute to resolving environmental, demographic, socio-economic, and political challenges through fundamental enquiry, often before their relevance is fully understood. This evolving mission must be matched by a commitment to diversity and equity. Doctoral education must actively reflect on and dismantle barriers rooted in social, economic, and cultural inequalities.

Diversity must be recognised as an integral part of excellence, rather than a threat to it. Institutions must cultivate an environment in which differences are acknowledged and valued, and in which diversity enhances the quality of research. It is equally important to protect and promote academic freedom. Doctoral education should provide an environment in which critical debate can flourish and doctoral candidates feel empowered to question, challenge and innovate without fear of reprisal. This includes defending their right to engage in controversial or unconventional research topics, particularly in political and social climates where freedoms may be under threat.

Doctoral education is increasingly delivered in various formats, including industrial doctorates, practice-based programmes, and interdisciplinary courses. While flexibility is vital, adherence to core principles must also be maintained, particularly the commitment to original research. Structured programmes must ensure that all formats of doctoral education remain connected to institutional governance and academic standards. Quality assurance is another critical concern. A fit-for-purpose system must go beyond compliance-driven checklists and publication metrics. The focus should instead be on the quality of research, upholding ethical standards, and encouraging a critical approach to evaluation and assessment. Meaningful indicators that reflect the depth, integrity, and impact of doctoral work should be emphasised.

As we saw, the development of transferable skills has become an essential element of the doctorate. Doctoral candidates must be prepared for a variety of professional pathways, not just academic careers. Communication, project management, and the ability to articulate and demonstrate one's skills are increasingly important. These skills should be embedded within the doctoral experience to complement, rather than detract from, the central focus on original research.

Supervision remains a cornerstone of doctoral education. While responsive to institutional capacities and individual needs, supervision must also be professionalised. Universities must invest in supervisor training and support to foster an environment conducive to academic and personal development. The quality of supervision is a key factor in doctoral success and satisfaction.

Finally, the issue of funding and employment conditions requires urgent attention. The appeal of doctoral study compared to other career options depends on living conditions, career prospects and how valuable a doctorate is perceived to be in different labour markets. Realistic funding durations and appropriate compensation are necessary to support candidates' well-being and the quality of their work. At the same time, expanding access to doctoral education must not lead to precarious or underfunded positions.

The future of doctoral education hinges on adapting its structures to changing realities and cultivating an inclusive, critical culture dedicated to the public good. These interconnected challenges require institutions to navigate the tensions between tradition and transformation, autonomy and accountability, and excellence and equity.

Conclusion

The purpose of this contribution was to highlight structural challenges and innovations in doctoral education as we move forward in response to contemporary academic, professional and societal demands. We analysed the structuration of doctoral education as the formal and informal processes, practices and frameworks through which doctoral training is organised, delivered and governed. Historically, doctoral education was an elite, apprenticeship-based model focused on academic reproduction. We view the restructuring of doctoral education as a dynamic and multifaceted process that, over the past two decades, has been driven by a commitment to enhancing quality, relevance, and impact while preserving the essence of doctoral research.

The recent development of doctoral education can be understood as a continuation of the process of raising the level of education worldwide and of emancipating research as a means of solving social problems. While industrial society was characterised by an increase in the number of people educated to acquire knowledge from others, the next phase of development is linked to the person being educated taking on a more active role – evolving from a passive recipient of knowledge to a co-creator of knowledge. This process is evident at all levels of education, but it is particularly important at doctoral level. Trends towards the democratisation of doctoral education can be observed: not only are there more candidates, who are also more diverse, but they are in a different, more active position.

The responsibilities and roles of all those involved in doctoral education have changed significantly. We presented the processes by which doctoral training is being reorganised and formalised through clear frameworks, standards and support mechanisms that go beyond the traditional apprenticeship model. This involves the institutionalisation of doctoral programmes, quality assurance processes, training in transferable skills, supervision guidelines, and support for the professional development of doctoral candidates. Going forward, institutions must strike a balance between structure and flexibility, standardisation and autonomy, and academic excellence and societal engagement. As demands on doctoral education continue to evolve, structuring efforts must be responsive, inclusive and aligned with local needs and global challenges. The 20th anniversary of the Salzburg Principles provides an opportunity to reflect on the need for a structured, inclusive doctoral education system that can meet the challenges of our time. During this period of reflection and renewal, it is crucial that we recognise not only that doctoral education is the foundation of research excellence, but also that it is a vital component of democratic, sustainable, and socially responsive social development. Doctoral training should remain a cornerstone of Europe's academic excellence, inclusive society and democratic future.

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Principles from the Bologna Seminar in Salzburg on "Doctoral Programmes for the European Knowledge Society", 3-5 February 2005. Conclusions and Recommendations

CHALLENGES IN DOCTORAL SUPERVISION

Peter Hanenberg[6]

Under the provocative title "PhD training is no longer fit for purpose – it needs reform now", *Nature* published an editorial in January 2023, which indicated several challenges in doctoral education, among which supervision is an outstanding factor. "Early-career researchers", so the editorial, "constantly report concerns about a chronic lack of support and poor-quality supervision, with senior researchers rarely trained in mentorship."[7] While this argument already seems to provide solutions to the problem (enhancing the support by training the supervisors), a deeper difficulty is addressed when the authors state that even "racism and discrimination are systemic in academic culture in many places".

Referring to a volume published in the same year under the title *Towards a Global Core Value System in Doctoral Education*, the editorial advances with some examples of good practices to make PhD training fit again for purpose, as e.g. the instruction "in cohorts with more than one supervisor, so that students are less isolated and better protected if a relationship with a single supervisor goes bad." And the authors also mention the advantages of transversal training beyond research supervision: "Some [PhD candidates] take additional courses of study or have their research progress assessed periodically - the kind of guided approach that happens in education more broadly."

What is supervision? Why is it so central and challenging in doctoral education? How can it be done so that it fits the purpose in leading the candidates to the conclusion of their PhD? What is needed on that way? The following three short chapters will try to provide answers to these questions. First, "International Recommendations" will be addressed, then we suggest a reflection on "Careful Agreements", and in the end, we present a brief proposal for "Supervisor Training".

The term "supervisor" translates in Portuguese into "orientador(a)". It seems that the two languages indicate different directions for the task in case. Whereas the work of an "orientador(a)" seems to be more suggestive and supportive than directive ("this might be a way to go"), supervision includes a notion of "superiority" and certainty ("that is the way to go"). In German, the term "Doktorvater" is more paternalistic, which might include the notion of a certain familiarity or proximity, but also of authority and dependency. Currently, terms like "tutor" or "mentor" are becoming more frequent (though not as the official and legal terms applied to the academic function) and seem to be understood in their educative functions based on a scientific community of peers. The uses of different words in different languages thus indicate how much the issue of supervision depends on the cultural conditions under which it is performed.

This observation is the starting point for the challenge in debate. On the one hand, it seems to be true that there is a common (if not a global) academic culture that confers to the PhD the status of an outstanding academic achievement and position. Considering

6 > Vice-Rector of Universidade Católica Portuguesa
7 > *Nature*, vol 613, January 2023.

the variety of traditions and experiences, this is, as such, a remarkable circumstance: no other academic and even no other civil title earns such a consistent international recognition as the doctorate. If it is true then, that a PhD has a globally similar "value", the cultural differences in terms of disciplines and in terms of regional or national contexts must not be neglected. It seems that the notion of a globally shared value of the doctorate is as much a guarantee of its continuous recognition as a prosperous ground of misunderstanding and misconception: between disciplinary cultures and between regional and national contexts.

Under the current social, economic, and geopolitical conditions, new challenges have arisen for doctoral education, which also impact the process of supervision. How much of PhD training can be subjected to the needs and interest of the industries, the so-called "non-academic contexts"? How much of the PhD is a strict scientific and, therefore, eventually primarily an academic affair? What will be the role of non-academic supervisors? Will the PhD still be recognized if the research performed is first and only in the service of innovation and competitiveness? How much "Ph" will then still be in the PhD?

Another recent challenge derives from the concerns of research security. There is an increasing apprehension about responsible internationalisation, also in the field of doctoral education and the recruitment of doctoral candidates. What if internationalisation and the recruitment of candidates are questioned by geopolitical suspicion concerning certain countries or regions? What if the best applications come from the most "suspicious" or problematic countries? Supervision is a matter of trust, and the conditions of trust have changed and led to a variety of potential conflicts or even misconduct.

It might also be because of these new conditions that the issue of supervision has to be addressed consciously and carefully. Supervisors tend to perform their tasks in the way they experienced supervision at the times when they were PhD candidates. However, the changing conditions of academia and society seem to demand a different approach to be fit for purpose.

International Recommendations

Twenty years ago, the conclusions and recommendations from the Bologna Seminar on "Doctoral Programmes for the European Knowledge Society" represented a milestone in the recognition of supervision as an essential element in doctoral education. Under point 5, the document claims:

> The crucial role of supervision and assessment: in respect of individual doctoral candidates, arrangements for supervision and assessment should be based on a transparent contractual framework of shared responsibilities between doctoral candidates, supervisors and the institution (and where appropriate including other partners)[8].

The document highlights the individuality of each PhD process while at the same time asking for a contractual framework in which the responsibilities of each party involved are transparently fixed. From here on, the forms and conditions under which supervision can be developed are recognised as core to doctoral education.

8 > Quoted from: https://www.eua.eu/downloads/publications/salzburg%20ii%20recommendations%202010.pdf

Five years later, the European University Association (EUA) already presented new insights introducing new ingredients for a successful supervision:

> As stressed in the fifth Salzburg Principle, supervision plays a crucial role. **Supervision must be a collective effort** with clearly defined and written responsibilities of the main supervisor, supervisory team, doctoral candidate, doctoral school, research group and the institution, leaving room for the individual development of the doctoral candidate. **Providing professional development to supervisors is an institutional responsibility**, whether organised through formal training or informal sharing of experiences among staff. Developing a common supervision culture shared by supervisors, doctoral school leaders and doctoral candidates must be a priority for doctoral schools. **Supervisors must be active researchers**.[9]

There are three new perspectives which allow for a more comprehensive understanding of supervision in its crucial role for doctoral education. First, the document highlights the collective effort at stake, indicating a range of agents involved in supervision. Beside the supervisor and the doctoral candidate, the document refers to supervisory teams and doctoral schools which have become an increasingly relevant reality, institutionalizing the doctorate as the third cycle in higher education. Another new perspective is the demand for professional development for supervisors, not just relying on an intuitive understanding of what this task implies. The professional development as a supervisor can be based on formal training or a continuous exchange with peers, contributing to the development of a supervision culture within the institution, be it on the level of a doctoral program or discipline or more comprehensively of a doctoral school. The third point clarifying the role of the supervisor stresses the need to be an active researcher, in line with the first Salzburg principle, stating that the "core component of doctoral training is the advancement of knowledge through original research".

This extended view of the crucial role of supervision for doctoral education is confirmed in another publication by the European University Association in 2022, now under the responsibility of its Council for Doctoral Education (EUA-CDE). In developing a "Vision for the Future of Doctoral Education in Europe", the title to the document is programmatic: *Building the Foundations of Research.*[10]

Stating that supervision is "key but not a solo act", the position paper consequently develops the former statements:

> Supervision is one of the central elements of doctoral education. The success of a doctoral project depends on its quality. Supervision is tasked with supporting the doctoral candidates through the whole research endeavour, and – at least in some European countries – assessing the quality of the doctoral research. Supervisors transmit necessary skills to the next generation and are key contact persons in case of any issues that may arise. Supervision is a joint endeavour in which supervisors, supervisee and the environment/school need to contribute and function. While the tradition of the single supervisor is still prevalent, it is now equally common for them to be part of a team with co-supervisors and advisers from inside or even outside the institution.

9 > https://www.eua.eu/downloads/publications/salzburg%20ii%20recommendations%202010.pdf
10 > https://www.eua.eu/publications/positions/building-the-foundations-of-research.html

While the recognition of the role of supervision is out of question, certain tendencies of change seem to be identifiable, both in terms of an institutional responsibility and a joint commitment of more than one supervisor. At the same time, an increasing notion of the difficulties at stake in supervision is openly addressed:

> Supervision also leads to several issues: there is an automatic dependency relationship between candidate and supervisor which cannot be easily overcome. Under good conditions, the relationship enriches doctoral education, but it can also lead to a variety of conflicts. These include questions of organisation of work, authorship and ownership of results, the work climate, and many more areas. Conventions on these questions vary between disciplines and countries. The work of a supervisor is increasingly complex, which leads to issues related to time and competencies. Engaged supervisors are confronted with the problems of doctoral candidates without always being able to contribute to problem-solving. They also have different, potentially conflicting roles. On the one hand, they have to ensure that work is done properly, and timelines followed, and they put the workload on the candidates. On the other hand, they need to give candidates the time and freedom they need.

As much as supervision is crucial, it can also offer the ground for a wide range of conflicts, be it in terms of personal attitudes, working habits, intellectual property rights, or any other standpoint or behaviour. And the issues and conflicts of supervision can affect both the supervisee and the supervisor, and both can find themselves unprepared to develop the right solutions adequately. Conflicting interests, uneven notions of rights and freedom pose a permanent challenge to all actors involved.

The position paper, therefore, suggests concrete measures that could help to mitigate the challenges of supervision. Such measures include the training of supervisors, the development of a supervision culture at the institutional level, and a transparent agreement between all stakeholders on "key aspects of supervision" at an early stage. Institutional procedures and guarantees for handling conflicts should be available.

It is this kind of definition that the *Marie Skłodowska-Curie Actions Supervision Guidelines* pretend to establish (and to make compulsory for the programs receiving funding under this scheme)[11]. Without going into the details of these definitions, there are five points which need to be addressed here. First, in the context of these guidelines, doctoral candidates are named "researchers", confirming the centrality of research in doctoral education and building a bridge to other moments in the academic career, as, e.g., post-doc researchers. Second, the demand for establishing an institutional supervision culture is enhanced and crystallized in the requirement of Supervision Frameworks, which formalize expectations, responsibilities and good practices. A third point is a dedicated chapter on "Supervisory Relationships", which gives room for defining conditions of communication and dialogue, including the demand for an open discussion of research and career development plans. Setting and discussing expectations helps to reduce or prevent the emergence of unexpected conflicts, to which "robust, transparent, confidential and impartial procedures" and adequate responses should be in place, based on a collaborative environment between the members of the research team, peers, and other networks. Therefore, and as a fourth point, the guidelines ask for institutional support structures, which include a formal and structured onboarding process, dedicated support services, and conditions to "create a diverse and inclusive workspace", thus committing the institution and all stakeholders to good practices concerning Equity, Diversity and Inclusion. Finally, the guidelines insist on offering training in supervision, which should be "mandatory at the beginning of supervision experience and then regularly refreshed through facilitated collegial discussion and/or follow-up sessions".

Though these guidelines do not apply immediately to every doctoral programme, they can be understood as valid references, allowing one to identify and implement good practices deriving from international experience and increasingly set up as a recommendable default at least in the context of doctoral training in Europe. The international debate has claimed the crucial status of supervision in doctoral education. An increasing awareness of the affordances and needs in the fields goes hand in hand with the promotion of good practices.

Careful Agreements

It might therefore be reasonable to specifically address one of the instruments which seem to be indispensable in the supervision process: the establishment of a thorough and careful agreement on what the supervision process should look like, a supervision agreement, signed by the supervisee, the supervisor(s) and, eventually, by other stakeholders. In the following, I will describe the core elements of a generic model for such an agreement, which might be adapted to the concrete circumstances of a concrete constellation in supervision, case by case.

In this sense and starting from my experience at my university, the first point I have recognised is that there might hardly be one fixed document that could fit all cases. On the contrary, if the exercise of defining the expectations, needs, procedures, and risks is not done in accordance with the concrete case, the agreement might be quite useless in practice and just a formal exercise. Therefore, the suggestion that follows does not offer predefined commitments or definitions, but, on the contrary, wants to give room to a guided and mutual understanding of what is needed in the supervision, counting on the active participation in its establishment by both the supervisee and the supervisor(s). Instead of offering a fixed document with rules and prescriptions, a questionnaire with open questions is suggested, which will guide the supervisor(s) and the supervisee to a joint identification of how their collaboration will work and develop. A supervision agreement would result from a joint discussion and a joint report on the issues raised in the several sections of the questionnaire. Additionally, some of the issues certainly will have to be revised over time and on a regular basis, taking into account the progress and experiences made so far.

The first section of the questionnaire on supervision addresses **general principles**. In this section the Profiles of the supervisor and the PhD candidate should be discussed, and the respective experiences and expectations should be provided. The section should also include a definition of the stakeholders in and outside academia who might be interested in or affected by the project or even involved in its development. This might help to clarify a common understanding concerning the societal dimension of the project and its expected impact.

11 > https://op.europa.eu/en/publication-detail/-/publication/1803a3f6-0084-11f0-9503-01aa75ed71a1/language-en

In the second section, the **integration of the researcher** should be indicated, namely the doctoral program in which the PhD is developed and the research centre, the research group and/or research line in which the PhD-project will be integrated. Furthermore, this section could reflect on the Support expected to be given by the Doctoral School or a similar structure and identify the activities and transversal training courses offered at the University that are supposed to be attended. The same section could address the relation with co-supervisors. If co-supervisors are to be appointed, the distribution of specific tasks and responsibilities should be transparently defined.

The third section is dedicated to issues of **research support**. The most important piece for this support is a research plan with clear goals and feasible indicators. This plan should be as transparent, as detailed and as comprehensive as possible. It should be subject to regular revision and scrutiny. Basic conditions must be clarified at this point: Which databases, archives, sources, and other devices are to be considered for a successful elaboration of the PhD project? Which instruments, software, or platforms are needed?

Another section should define the **procedures and processes** concerning the supervision. A plan for regular meetings can be very helpful. Supervisors and supervisees might decide if the minutes of these meetings should be in written form and how they will be used. Expectations for feedback should be clarified. This item needs to be revisited after a certain period or even regularly. Of special relevance is also a reflection on the writing process. The starting date for writing, forms of training (e.g., at the Doctoral School), and support during the process (reading, commenting, suggesting, correcting) should be defined.

The fifth section should clarify issues of **intellectual property** and co-authorship in accordance with institutional regulations. Practices concerning co-authorship differ from discipline to discipline and from academic culture to academic culture. The potential for conflict in this case is huge. Therefore, it might be advisable to promote an open discussion, maybe not just between supervisor and supervisees but extending the reflection to a group of peers.

Other challenges to address, as early as possible and not just during the final stages of the process, are matters of **career development**. The *European Competence Framework for Researchers* (ResearchComp) should be discussed at this point[12]. Which training activities could be considered for future career development? Also, the access to conferences and publications might be clarified. On a regular basis, opportunities for participation in conferences or publications should be defined, including their role in the overall process. Will the publications be part of the PhD work, and in which sense? The potential future development must be discussed at this point. Which expectations exist concerning the time after a successful PhD? Are there any plans? Which measures should be taken to reach them, even before the completion of the PhD?

Plans for **Internationalization** might build another section. Is any mobility period foreseen? Which international cooperation is needed or might be beneficial for the process? Is any cotutelle agreement foreseen? Will it lead to a double degree? Which conditions for co-supervision can be defined on that basis?

12 > https://research-and-innovation.ec.europa.eu/system/files/2023-04/ec_rtd_research-competence-presentation.pdf

Issues of **funding** should not be left out of the agreement. There should be a clear understanding of the funding conditions, both on the side of the supervisor and the supervisee.

Though issues of **integrity and ethics** are a concern that exceeds the relationship between supervisor and supervisee, they should be actively addressed. The supervisor must make sure that relevant codes of ethics (in the institution or beyond, like the ALLEA code, *The European Code of Conduct for Research Integrity*[13] by the European Federation of Academies of Sciences and Humanities) are considered and adopted. Bad practices of plagiarism should be openly discussed. A common awareness of concrete examples might avoid unethical practices. The uses of AI should be addressed and defined: How can AI be used in the research and writing process? Institutional recommendations must be known and respected. The supervisees should further be informed about the work of relevant Ethics Committees, and it should be defined if and when the PhD project should be submitted to the Ethics Committee.

Statistically, the number of PhD candidates who suffer from challenges to **well-being** and even mental health is high. The percentage of common health disorders among researchers is higher than in the general adult population (37% to 19%). 50% of PhD candidates experience psychological distress, and 33% are at risk of a common psychiatric disorder[14]. Awareness of risks to well-being and health might help to identify adequate preventive measures. Institutional support structures should be acknowledged even before their intervention is needed or recommended. A careful supervision agreement, therefore, is open to these issues and establishes the necessary procedures to monitor challenges ahead.

The last section of the agreement should clearly indicate measures and procedures for **conflict resolution**. Depending on the institutional regulations, immediate instances might be the program coordinator, followed by an ombuds(wo)man, the dean of the school, or any other instance indicated by the institution.

The establishment of such a careful supervision agreement needs dedication, effort, and time – even before any concrete scientific research issue is addressed. It might work as an invitation to develop the PhD project on a solid common ground of understanding shared by the supervisor and the supervisee. Neither the former nor the latter might immediately be ready for such a demanding exercise. Therefore, the introduction of a careful supervision agreement should be embedded in a process of institutional learning in which neither party is left alone. In the end, such processes are essential in the development of a proper supervision culture, fit for purpose in the service of a successful doctoral education.

13 > https://allea.org/code-of-conduct/

14 > Stéphanie Gauttier: Ethics of supervision - responsibilities of supervisors & supervisees; http://www.eurodoc.net/sites/default/files/attachments/2021/404/presentationofstephaniegauttier.pdf

Supervisor Training

In this context, a final suggestion concerning supervisor training might be useful.

While preparing this paper for the A3ES conference in November 2024, I asked Microsoft Co-Pilot, what the main topics were for supervisor training on the doctoral level. The Artificial Intelligence provided the following answer:

> Supervisor training at the doctoral level typically covers a range of important topics to ensure effective guidance and support for doctoral candidates. Here are some of the main areas often included:
>
> 1. **Recruitment and Selection:** Strategies for selecting the right doctoral students, considering their research potential and alignment with the supervisor's expertise (1,2).
>
> 2. **Roles and Responsibilities:** Clarifying the roles and responsibilities of supervisors, including setting expectations and monitoring progress (2).
>
> 3. **Communication and Leadership:** Effective communication techniques and leadership skills to foster a productive supervisor-student relationship (3).
>
> 4. **Supporting Wellbeing:** Recognizing and addressing mental health issues, and providing support for the overall wellbeing of doctoral students (2).
>
> 5. **Research Culture Integration:** Helping students integrate into the research culture and community, including networking and collaboration opportunities (1).
>
> 6. **Legal and Ethical Issues:** Understanding the legal and ethical considerations in doctoral supervision, such as intellectual property rights and research integrity (4).
>
> 7. **Career Development:** Supporting the professional and career development of doctoral students, including guidance on publishing, presenting, and job searching (2).

These topics aim to equip supervisors with the skills and knowledge needed to effectively mentor and support their doctoral candidates throughout their research journey.[15]

The topics generated by the AI confirm, in large terms, the description given above on the needs and issues to be addressed in a careful supervision agreement and thus translate immediately into training requirements. An expanding theoretical and practical discourse on supervision training is taking place, to which the sources quoted by Co-Pilot and indicated in the footnote below are good examples.

15 > Quoted from Copilot, 04/11/2024. The numbers refer to the following sources used by Copilot:
(1) Doctoral Supervision: A Best Practice Review - MDPI. https://www.mdpi.com/2673-8392/3/1/4.
(2) Fundamentals of PhD Supervision | Institute for Academic Development. https://institute-academic-development.ed.ac.uk/research-roles/supervisors/fundamentals-of-phd-supervision
(3) Supervisor Training - TUM Graduate School. https://www.gs.tum.de/en/gs/supervision/supervisor-training/.
(4) Goethe-Universität — Training for Supervisors. https://www.grade.goethe-university-frankfurt.de/54290133/280_training_supervisors.

The *DocEnhance* project, funded by the European Union's *Horizon 2020 Science with and for Society program*[16], has also contributed to the debate by offering a PhD supervision course on its recommendable platform.

The authors have defined the challenges in supervision in the following way:

> As a supervisor, you are dealing with many issues like:
>
> - how to build a favourable environment for doctoral candidates,
> - securing funding,
> - supporting candidates' wellbeing, mental health and resilience
> - managing your own role [...]
> - how to take into account both the PhD process and product (the thesis writing itself) [...]
> - how to develop & upskill yourself both pedagogically and in research competence [17]

Building on these issues, the course offered on the *DocEnhance* platform addresses the following topics:

Part 1: What is supervision? The field, concepts, tools and case studies

1. The essentials in research supervision: The concepts, new demands and local organisational frames & responsibilities for training, transparency & quality.
2. Models of supervision: analysing roles, responsibilities, expectations, and supervision styles

Part 2: Building core supervisory skills and competences

1. Mapping expectations and analysing your own experience as a supervisee and a supervisior
2. Relational aspects and the importance of quality feedback
3. Diversity and intercultural supervision
4. Analysing and developing your supervision style

Part 3: Collaboration in doctoral education

1. Preventing conflict and problems in supervision
2. Internationalisation
3. The non-academic sector and the importance of identifying and building broader skills sets[18].

16 > https://docenhance.eu/
17 > https://courses.docenhance.eu/course/view.php?id=4
18 > https://courses.docenhance.eu/mod/page/view.php?id=366&forceview=1

The wide range of topics and issues provided in these examples draws attention to the necessity of considering the diverse and changing conditions under which doctoral education is taking place. Once again, it is not that just one size fits all. Therefore, I would like to add three more specific issues deriving from my own practice at the Católica Doctoral School CADOS in Portugal and the supervisor training we develop.

Since the pandemic and in the context of an increasing internationalisation, especially fostered by the European University Initiative, **intercultural online supervision** has become more frequent. Therefore, supervisors should be trained in their role and in the specific affordances of online supervision. I have identified six points of special importance when it comes to online supervision in an international context. In line with what has been explained above, supervisors and supervisees need to define their expectations, both in general terms and in terms of the online procedures, taking into account the specific affordances and requirements in terms of the institutional and international setting. Furthermore, supervisors need to be trained in techniques of feedback, both in onsite and online supervision. Feedback is tightly connected to communication skills (verbal and written), emotion management, and the development of a culture of transparency, co-implication in the process of supervision, and radical responsibilisation of both the advisor and advisee. The effectiveness of certain techniques of feedback varies a lot between onsite and online supervision and cannot simply be transposed from one situation to another. Additionally, intercultural supervision is especially sensitive to different forms and cultures of feedback. Therefore, online supervisors must take into account that cultural differences do not diminish in the same way as the common use of online technology might suggest.

In many cases, online supervision goes hand in hand with an international and interinstitutional team of supervisors who are subject to intercultural challenges and institutional and individual expectations. An offer of transversal supervisor training would be necessary to ensure common procedures and balance of requirements in supervision across a university alliance or in any other international collaboration.

Under these circumstances, the above-mentioned supervision agreements and supervision records are indispensable means. They allow transparency both for the international supervisor teams and for the PhD candidates in each moment of the process. Joint and online supervision is especially sensible to issues of scientific integrity and to mutual respect of (personal) data protection. Recordings of supervision sessions are good means to prevent misunderstandings, to keep memory of the progress and to document any eventual conflict or even harassment. On the other hand, this material must be shielded from any public dissemination or other forms of misuse.

This leads us to another urgency in supervisor training: **the use of AI** in terms of research ethics and integrity. Supervisors and supervisees need to understand what is possible, allowed, desirable, and recommendable. Academia in general does not seem to be well prepared in this field and oscillates between enthusiasm, fear, and despair. The European Code of Conduct for Research Integrity includes "Hiding the use of AI or automated tools in the creation of content or drafting of publications" among the violations of good research practices and as an example of unacceptable practices. Supervisors should be trained to identify such misuse and to promote good practices in disclosing and reporting the use of AI and automated tools.

As mentioned in the introduction to this paper, the current geopolitical challenges widely impact doctoral education, and therefore also supervision and supervisor training. The last five years have given evidence of a new understanding of **Universities as Lighthouses of our European Way of Life**. As defined in the *European Strategy for Universities*[19], a new public demand for strengthening quality and relevance for future-proof skills is on the agenda, definitively dismantling the notion of the University as an ivory tower or as a well-protected silo. Competitiveness and acceleration describe the new terms under which the work of universities is understood and recognized, including the establishment of flexible and attractive academic careers and better access to excellent science. Doctoral education is at the center of these demands. Therefore, a continuous effort in improving practices of and through training and supervision is needed.

20 years after the Salzburg principles, there is no doubt: in doctoral education, supervision is crucial. However, good supervision cannot be taken for granted. The way to successful supervision must be carefully agreed upon in each case. It is promising and risky, learning and training, the articulation of experience and innovation. Preparing the next generation to become fit for purpose: facing the challenges ahead.

19 > https://education.ec.europa.eu/sites/default/files/2022-01/communication-european-strategy-for-universities--graphic-version.pdf

DOCTORAL EDUCATION IN TRANSITION: ADDRESSING CHALLENGES FOR INSPIRING CHANGE

Margarida Lino de Sousa Estêvão[20]

The Doctoral Pathway: The Students' Perspective

The discussion about doctoral education, its challenges and future opportunities should, without question, take place at a table with a seat reserved for students. In order to continue working on an educational model whose aim is to educate specialists in a wide variety of areas, it is absolutely necessary to know the obstacles that those individuals face and (re)think transition strategies towards more efficient models. Thus, it is my aim to address the perspective and challenges that doctoral students face during their doctoral career. Nonetheless, being myself a doctoral student, it is not possible to assume that this specific perspective is a *one-size fits all* and shared by all doctoral students everywhere, nor, likewise, that it is disconnected from a very personal experience – my own[21].

Having said that, being this the kind of conversation that could occupy more than a brief dinner, sounding more like awkward family dinners in which conversations topics seem to repeat every time, I decided to limit this discussion to a specific set of subjects: 1) institutional integration; 2) the relationship with advisors; 3) funding and financial insecurity; and 4) final and general reflections with an honorary mention of university-industry/business collaborations and the compulsory curricular year.

1. Tell me your research center and I'll tell you who you are

Any doctoral path, regardless of its purpose, scientific area or space-time context, implies affiliation with a particular university or research center. Even so, it's important to recognise that not all academic paths are the same and that two students with the same institutional affiliation may still face different obstacles.

First of all, there is a difference between those who choose a continuous academic path – especially if it takes place in the same institution –; and those who choose, or were obligated by whatever circumstances, to have more irregular paths, with stops, periods of time taken up with other experiences, professional or otherwise, changing between institutions for different studies' cycles. If, on the one hand, diverse paths can provide students with different skills and useful experiences, it seems plausible to admit that the integration processes, and therefore the challenges faced, will also be different. I was lucky enough to have the liberty to decide where and when I wanted to study my whole life, and thus I did choose to do my master's and PhD at the same institution, knowing from an early period that I wanted to pursue an academic and scientific career. This allowed me to spend the years of my master's and the first years of my PhD getting to

20 > PhD Student, Iscte-IUL

21 > That said, it might be important for the reader to know that I'm a Portuguese PhD Sociology Student in the third year of my doctoral program – I do like to present myself as a Political Sociologist – and I do have a scholarship from the Foundation for Science and Technology.

know professors and researchers, making known my willingness and interest in joining scientific activities, getting to know the dynamics of the research centers, observatories and other institutional architectures. Hence, by the time I started my PhD, I was familiar with a large part of the group of professors and the scientific areas they were involved in; the internships; international projects and agreements; conferences and seminars that the research center organised; even the names of the technical staff working there. There was enough time for me to move around the university halls, to get to know its nooks and crannies. Beyond the academic and scientific culture of the doctoral program, there was enough time for me to understand the underlying professional culture of the university I attended.

The case is different for a student who has just entered the first year of a doctoral programme at an institution he or she has never attended. There is an institutional, scientific, professional and social culture that is completely unknown to this student, to which he or she is thrown to and must adapt. Trying to prevent the fictional scenario of a student being thrown to the wolves in the reader's mind, there are, in fact, strategies aimed to ease this institutional integration. To my knowledge, the majority of the Portuguese doctoral programmes offer a first curricular year with both methodological and theoretical classes, which do indeed provide moments of socialisation and integration. Moreover, most of these programmes also offer seminars during the following years of the programmes, in which students are given the opportunity to discuss their theses and products of their PhD with their peers.

This is obviously positive, but I still argue that it is not enough to promote a more equal level playing field among students who, for one reason or another, start the doctoral programme with different levels of institutional integration. As such, it may be time to explore strategies other than those already in place: 1) the creation of spaces within these institutions that promote co-working and collaborative work; 2) institutional architectures that physically bring students and research centers closer together; and, for example, 3) the integration of students into specialized research groups, according to the theme of their research, creating synergies between more experienced researchers and doctoral students, in order to expand the idea of seminars beyond the student group.

Finally, it is necessary to point out the relationship between institutional integration and funding within doctoral education. The integration of doctoral students into research centers – that is, their inclusion in a specific working or research group, for example – is often limited by the funding condition (or not) of their doctoral programme: it is more common for a student with funding to have access to more formal scientific groups – perhaps even within the framework of a project which is also funded and which entails the development of the student's doctoral work within that context – with more regular formal meetings, designated work spaces and so on. Hence, once more, inequalities between students regarding institutional integration are reinforced.

2. It takes two to tango

Realizing that I may run the risk of tiring the reader with some thematic repetition, as far as the relationship with the supervisors is concerned, it's clear that the above-mentioned contrasts in terms of institutional integration also impact this dimension.

Most of the time, depending on the bureaucratic requirements of each institution, doctoral students must choose a supervisor during the first year of the doctoral programme. This means that, often, students have to make a decision without any knowledge or familiarity regarding the other person's way of working beyond what the academic and scientific curriculum dictates. It's common to decide based on the scientific area or the recognition of that personality in a given research center, but there isn't always compatibility between the ways of working of those two or three people.

I do believe that it really takes two to tango and, so, these relationships are built by all parties involved. As such, sometimes, these rushed decisions lead to various challenges: whether it's because the student needs more personalised and close monitoring and the supervisor doesn't have that kind of time and availability, be it because the student prefers to work more autonomously and it's difficult for the supervisor to monitor the work progress and to be involved. Having said that, I believe it's important that the decision to choose an advisory team is increasingly detached from institutional constraints, be it in terms of timing and specific time limits, be it in terms of the advisor's affiliation with a particular center. In addition, there should be a time for reflection, conversation, space and time to establish the rules of the game between students and supervisors, the expectations of that supervisory relationship and of the doctoral pathway in general.

Finally, I have been lucky enough to work with two supervisors whom I hold in respect and affection, and in whom I find different skills, often different perspectives and opinions, which I consider to be absolutely decisive in the progress and success of my journey so far. I do know, however, that this is not always the case. Speaking of more serious cases, beyond these obstacles that I have mentioned, where there is a total disappearance of the supervisor, the attempt to impose a certain line of research, the overloading with work outside the student's line of research and their doctoral project, in these cases, which unfortunately still occur, I stress the undeniable importance of institutional intervention, namely of the director of that specific PhD programme. It is necessary that there is openness and bureaucratic facilitation in the inclusion, exclusion or change of advisors. Whether for the most unfortunate reasons or because, on good terms, that student and that advisor conclude that that particular orientation no longer makes sense.

3. Funding and economic insecurity

To discuss the obstacles that appear within the economic sphere, it's important to understand that at least three different pictures, with different challenges, can occur: 1) the student has some kind of funding, be it a public scholarship, private funding, any other kind, and thus has the possibility to carry their doctoral project and devote themselves to it full-time; 2) the student did apply for these types of funding and ended up not getting any; 3) the student, by choice, decided not to be bound to a scholarship and carry the doctoral project without funding.

For the last two pictures, in which there's no funding involved and in cases where students need to divide their time between their PhD and other source of income, be it a full-time or part-time job, it's, first of all, unreasonable to believe they're going to be as involved with the institution and with their PhD as students who have the opportunity to be dedicated to the PhD full-time.

I don't think we should override the possibility of an individual having the liberty to choose to do a PhD out of a desire to know more, to specialise in a certain area without wishing to abandon their main professional occupation. However, I do believe that PhDs should be seen more as a professional occupation and that we should stop labeling doctoral programmes as a mere study programmes. PhDs students are hardly just studying. In this sense, for me, it's necessary to create conditions so that those who wish to do so have the chance to go through their doctoral pathway without the burden of balancing, in my view, two jobs: one that provides them with a de facto income and, often, the bare minimum of subsistence, and another, the PhD, which allows them to do what they like, constituting, at times, a necessary step to build the mandatory curriculum to carry out the professional functions and positions to which they aspire.

Having a scholarship myself, I identify other challenges. Although it has no material effects, this culture that PhD students are only studying can be stressful and exhausting. I have found the doctoral pathway to be quite a fluctuating one. There are indeed times when the workload is lighter, moments when there is flexibility in organizing the routine according to each individual's preference. However, the opposite is also true. There are times when the workload is heavier, when it's difficult to define the boundaries between the working period and the rest and personal time. Periods when there is a frenzy of publishing, submitting papers to conferences, collecting data more intensively. Labelling a week's work as "just studying" is frustrating, fosters cultures of overwork and disconnects doctoral students from the traditional professional world to the extent that they, or we, include ourselves in a somewhat isolated bubble, difficult to define, which can pose challenges in interpersonal relationships and in the person's own professional and personal identification.

Still, and to close this topic, among the lucky ones who do get scholarships or other kinds of funding, I also identify the challenge of the bogeyman of the future. The way doctoral scholarships are set up binds the student to the development of their thesis with an exclusivity clause. Teaching activities with a certain number of hours and other activities are allowed, but, in general, there is an attempt to restrict the student from practicing other professional activities during the period in which they benefit from the scholarship. This implies, in my opinion, that for 3, 4, 5, 6 years, that individual builds their curriculum based on the development of academic-scientific activities, withdrawing from the so-called traditional professional world. What happens when the scholarship ends? This poses a logic of scholarships-dependence that paints a picture of uncertainty and insecurity. After defending his or her thesis and ending that period of funding, a doctoral student finds himself or herself in a situation where he or she must quickly find another scholarship or readapt and join the traditional professional world. Even though I'm not at that point yet, this is a concern that hangs over me a lot.

4. Other challenges and reflections

I am myself studying individual and collective trajectories and I don't want to make any kind of generalization about doctoral paths. Each pathway is unique, and, so, there will certainly be obstacles that are specific to each individual, and others that are perhaps common to several pathways that I haven't mentioned. In any case, I'd like to close by sharing a few loose ideas that I was led to reflect on when I was challenged to make this intervention.

There seems to be a small shift in the way doctorates are thought of, both in Europe and in Portugal. Doctoral programs are no longer seen only as a degree of research and an entry requirement for academic positions, but as a channel for innovation and capacity to shape individuals able to respond to the needs of society, economy and the job market. Even though this isn't the reality I'm most familiar with, it makes me wonder if this shift doesn't imply an adaptation of the doctoral curriculums. Does it make sense for the traditional, theoretically oriented model, with the central purpose of constructing an original thesis, to be applied to these PhD programs with different future, professional, practical purposes? I don't intend to defend an extreme division of the utilitarian or non-utilitarian role of science and knowledge, but under the banner of academic freedom and autonomy, perhaps it would be useful to adapt doctoral curriculums according to the purpose of that specific degree.

In the same sense, the question of the compulsory curricular year also arises. On the one hand, I believe that this year is not always useful, be it because, sometimes, it ends up being a repetition of previous study programme without adding or deepening methodological, theoretical or transversal skills – and here I raise the question for more oriented master programmes that fill in these blanks. However, on the other hand, I believe that the curricular year often serves as a year of balance, adjustment, and calibration between the peers that are part of a specific doctoral programme: it is not viable to consider that a specific real group of students that starts the first year of a doctoral programme tears off with the same skills. In this sense, for me, the discussion should be different: not as much the extinction of this curricular year, but its adaptation, namely with the replacement of some seminars, curricular units from compulsory to optional. While offering the necessary tools to those who find them useful but preventing certain dynamics of segregation and significant gaps from happening.

5. Conclusion

Doctoral program models have been the focus of discussion in order to better adapt them to the needs of society and the job market. I don't disagree at all with this concern about keeping study cycles adapted to progress and to new concerns and needs that may be arising; however, it is necessary to ensure that students are part of this conversation. That was precisely the aim of this reflection: to highlight the dimensions in which doctoral students continue to face challenges, identifying them so that the discussion can remain lively and the scientific community can continue working to find better and better solutions. That said, when it comes to discussing doctoral education, save me a seat at the table and I'll always be available to contribute.

DOCTORAL TRAINING IN TRANSITION – ADDRESSING CHALLENGES FOR INSPIRING CHANGE (STUDENTS' PERSPECTIVE)

Nora Angelova[22]

Doctoral education in Europe is undergoing a period of transformation that reflects broader changes in society, academia, and the labour market. From a student's perspective, the process of completing a PhD is both intellectually rewarding and personally challenging. This reflection highlights the pressing issues that doctoral students encounter—ranging from insufficient mentorship and financial insecurity to mental health struggles and unclear career trajectories. Drawing from personal experience and student advocacy work, I will outline key challenges and propose ways to inspire positive change in doctoral training.

One of the primary challenges faced by doctoral candidates is the lack of adequate guidance and mentorship. According to a 2020 report from the European University Association, 35% of doctoral students reported insufficient mentoring or vague academic direction from their advisors. This deficiency often leaves students feeling unsupported and directionless, which can hinder their academic progress and personal development. Effective supervision is a cornerstone of successful doctoral education, and the absence of it significantly undermines students' experiences.

Another substantial concern is the imbalance between research and broader skill development. Doctoral education is still predominantly research-focused, often at the expense of equipping students with essential transferable skills such as leadership, communication, and interdisciplinary collaboration. These competencies are critical not only for academic success but also for employment in non-academic sectors. When doctoral training programmes do not actively promote these skills, they limit the student's versatility in an increasingly dynamic job market.

The doctoral journey is also marked by isolation and mental health challenges. A 2021 survey conducted by the European University Association found that 40% of doctoral students experienced stress, anxiety, or burnout. The solitary nature of research, combined with intense academic pressure and uncertain future prospects, creates a mental health crisis that must not be overlooked. Support services are often insufficient or poorly tailored to the specific needs of PhD candidates, compounding the emotional toll of academic life.

Career uncertainty adds another layer of stress. While many students begin their PhDs with aspirations of entering academia, the reality is that only 30% of PhD graduates in Europe manage to secure permanent academic positions, as reported by the European Commission in 2020. This leaves a significant majority navigating a transition to non-academic careers, often without adequate career counseling or training in transferable skills. The absence of structured career guidance leads to frustration and uncertainty about post-PhD pathways.

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Financial challenges are another persistent barrier. Many doctoral students struggle to obtain funding sufficient to cover tuition fees, research costs, and living expenses. Eurostat data from 2020 revealed that 27% of doctoral candidates in Europe have no funding support and rely entirely on personal savings or family assistance. Even when stipends are provided, they are frequently inadequate. For example, in countries such as France and Italy, monthly stipends often fall below €1,000, which does not meet the cost of living in major cities. This financial strain compromises the academic focus and well-being of students.

Addressing these multifaceted challenges requires a comprehensive and collaborative approach. Enhancing financial support is fundamental. Universities and governments should increase the availability of scholarships and grants, expand funding for career-related development, and provide financial literacy programmes to help students manage limited resources more effectively. Institutional support must also include mental health services, such as counseling, peer support networks, and stress management workshops tailored to doctoral students.

Career development must become an integral part of doctoral training. Programmes should offer structured career guidance, including workshops and internships that expose students to both academic and non-academic career opportunities. This must be complemented by professional development initiatives that prioritise skills like leadership, interdisciplinary teamwork, and effective communication.

Mentorship structures also need significant reform. Formal mentorship programmes and peer support initiatives can help create a more connected academic environment, offering students both academic direction and emotional support. When students have access to multiple mentors and peer networks, their sense of isolation diminishes, and their chances of success increase.

Doctoral students consistently express the need for more personalized training paths. Programmes should allow flexibility to accommodate individual career aspirations—whether in academia, industry, or the non-profit sector. In addition, there must be broader recognition of holistic development, with equal emphasis placed on academic performance, professional growth, and personal well-being. Students thrive in environments where their multifaceted identities and ambitions are acknowledged and supported.

The voice of doctoral students is critical in shaping the future of doctoral education. Active student participation ensures that reforms reflect real student needs and experiences. Organisations like the European Students' Union offer platforms for engagement, such as the Task Force on Doctoral Students, where students from diverse backgrounds can contribute to policy development and institutional change.

In conclusion, transforming doctoral training in Europe demands that we listen to students and act on their insights. By addressing the key obstacles—mentorship deficits, financial hardship, mental health concerns, and career uncertainty—we can build more supportive, inclusive, and forward-thinking doctoral programmes. Change is not only possible but necessary, and it begins with recognising that students are not just recipients of education—they are active contributors to its evolution.

EUROPE AND THE NEED TO ALIGN, ACT AND ACCELERATE RESEARCH AND INNOVATION:

NEW CHALLENGES AND OPPORTUNITIES FOR "RESEARCH INTENSIVE" DOCTORAL EDUCATION

Manuel Heitor[23]

Abstract

The need for continuously modernising doctoral education in Europe in close articulation with research and innovation is discussed in terms of emerging requirements to accelerate our collective response to geopolitical threats, boost innovation in defence and security, and rethink our understanding of "science for policy" in times of knowledge abundance. Over three years into the war in Ukraine and with a new US administration in place, it is critically important to emphasise that Europe is the world's most reliable partner – and the most efficient in terms of outputs per resources, thanks to our diversity. Building on the *Letta, Draghi, Heitor and Niinisto* reports of 2024, while investment capacities still lag behind, we now have a unique opportunity to **advance doctoral education in very close articulation with research and innovation** towards Europe´s strategic autonomy on a world level. But we must strengthen and reform our funding systems to promote greater risk-taking, faster decisions, and institutional tolerance for failure. Doctoral education, together with the Choose Europe initiative to foster research careers, should be promoted without any hesitation and with adequate investment levels to turn the European brain drain of last decades to the US into a brain gain. The *Union Strategy on Preparedness* mark key steps in this direction, but requires to better *Align, Act* and Accelerate Research and Innovation.

1. The context: *a new complex of uncertainty*

Europe is facing an unique opportunity to better foster knowledge towards its strategic autonomy at a world level. In a context of knowledge abundance, we all face new challenges for "scientific activism" to face uncertainty, together with the fragmentation of multilateralism and the polarisation of our societies.

Doctoral education plays an critical role in this context. But its analysis and continuous evolution must take into account the work of the German sociologist Klaus Eder[24], together with that of Josef Henrich (2016), for whom learning is not the same as cultural

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24 > Eder, K. (1993), "The New Politics of Class: Social Movements and Cultural Dynamics in Advanced Societies", SAGE Publications.

evolution. **Social learning does not change the world, but it provides the elements to change it.** It promotes an increase in the evolution of behaviors, expanding the scope of possibilities for evolution. In other words, doctoral education and research, together with collaborative research and innovation, must be understood as a "cultural movement" involving institutional innovations to address processes of stimulating generational change.

Over three years into the war in Ukraine and with a new US administration in place, we clearly know that Europe is the most reliable partner at a world level, the most efficient by outputs per resources thanks to our diversity. Our values and democracies are a world reference, to be preserved and strengthened, at any cost. Obviously, Europe is lagging behind in terms of Research and Innovation (R&I) investment and a lot of improvements and even changes are necessary. But we all are facing an unique opportunity to make it happen, and Align, Act and Accelerate our policies[25] to evolve from the current situation:

- As measured by the top **1% most cited scientific publications worldwide, the EU ranks third, behind China and the USA**, with its share of the total declining from 20.7% in 2000 to 17.8% in 2020. The European Union ranked second globally for the total number of scientific publications, behind China and ahead of the USA, and accounted for 18.1% of the global total in 2022, amounting to approximately 650 000 publications. Over the past two decades, the EU's contribution to global scientific publications has dropped from 25.5% in 2000 to 18.1% in 2022;[26]

- From 2005 until 2015, the EU was leading the world in terms of scientific AI publications (37%), followed by China (34%) and the US (29%). However, by 2021 China had surpassed both the EU (30%) and the US (28%), accounting for 42% of publications[27]. Looking at the breakdown per sector, the EU ranks second in all of the four main sectors (i.e. health, environment, transport and agriculture), while the US leads in health and China in the other three. As China steadily enhances the quality of its publications (measured as top 10 % most-cited scientific publications), the **EU has descended to the third position globally**, closely trailing the United States.

- The EU's share in total patent applications has been declining in recent decades. Accounting for around 30% of the world's patent applications in 2000, the EU's share declined to 17.3% in 2021. Between 2014 and 2020, the EU led in global high-value patent filings related to renewables (29%) and energy efficiency (24%), but lost ground in smart systems (17%) ranking fourth after the US, China and Japan;

- **EU´s technology base is more diversified than that of other major economies**, but the EU is disproportionally more specialised in less complex technologies than its counterparts. Although the EU is a technological leader in certain high-tech industries (e.g. EUV and High-NA lithography machines by ASML, among many other examples), China has been leveraging its status of factory of the world to establish new standards globally and helping downstream industries (e.g. EVs) to vertically integrate with high tech industries (e.g. semiconductors, advanced materials) and has been successful at reshuffling the level global playing field in general. The main point here is that **EU has lost technological leadership** in some domains that it had before (e.g. software services) and has not kept up with other new areas. In general, analysis shows that: i) The EU shows a higher specialization in food chemistry, climate and environmental technologies; while ii) The US and China are leading in areas related to digital technologies such as semiconductors, computer technologies, optics, digital communications and audio-visual technologies, which are the expected to be key drivers of growth in the near future[28];

- **Europe has kept civilian and military research and innovation systems apart**. In contrast, the US has successfully linked disruptive science, innovation and technology development to US defense policy, allowing it to meet national security needs and simultaneously benefiting US economic growth and competitiveness through commercial applications. Similarly, China has pursued civil-military fusion for many years.

25 > https://op.europa.eu/en/publication-detail/-/publication/2f9fc221-86bb-11ef-a67d-01aa75ed71a1/language-en
26 > https://op.europa.eu/en/publication-detail/-/publication/2f9fc221-86bb-11ef-a67d-01aa75ed71a1/language-en
27 > EC (2023).

The 'Align, Act, Accelerate' report of October 2024[29] should be understood as a comprehensive analysis of European R&D programmes often mentioned alongside the "Letta Report" (April 2024[30]), the 'Draghi Report' (September 2024[31]) and the "Niinisto Report" (October 2024[32]), respectively on European internal market, competitiveness and security— they all clearly note an urgent need for Europe to unite its forces: i) Our collective response to escalating geopolitical threats must accelerate; ii) We must expedite our research and innovation in Defense and Security, together with *Prevention, Preparedness and Readiness; and* iii) These should be associated with evolving understanding of "science for policy" in times of deep transformation[33].

This paper thus focuses on the prospective analysis of the conditions for **promoting knowledge through doctoral education** as a critical factor for competitiveness and for facing emerging societal challenges at a global level in the growing "uncertainty complex" that we are witnessing at an international level[34]. It includes four volatile and interactive aspects:

i) the **fast rate of technological change** in which we live, in a context of increasing abundance of knowledge and, above all, information, with the exponential growth of scientific publications on a global scale, including a new relevance of science produced and disseminated in China[35]. This has stimulated new initiatives of "technology

28 > EC (2024)
https://www.openaire.eu/looking-to-the-future-science-research-and-innovation-performance-2024-e-u-report
29 > The so-called Heitor Report, as available in
https://op.europa.eu/en/publication-detail/-/publication/2f9fc221-86bb-11ef-a67d-01aa75ed71a1/language-en
30 > https://single-market-economy.ec.europa.eu/news/enrico-lettas-report-future-single-market-2024-04-10_en
31 > https://commission.europa.eu/topics/eu-competitiveness/draghi-report_en
32 > https://commission.europa.eu/topics/defence/safer-together-path-towards-fully-prepared-union_en
33 > See European Commission: Joint Research Centre, SCHWAAG-SERGER, S., SOETE, L. and STIERNA, J., Scientific Report - For an Innovative, Sustainable and Fair Economy in Europe, Publications Office of the European Union, Luxembourg, 2024, https://publications.jrc.ec.europa.eu/repository/handle/JRC140513
34 > See, for example, CEPS Ideas Lab (2025), March 2025, https://www.ceps.eu/ceps-publications/2025-ideas-lab-report/. Também, https://www.ceps.eu/ceps-publications/unpredictable-tariffs-by-the-us-implications-for-the-euro-area-and-its-monetary-policy/
35 > See, for example, Marginson and Yang (2001) and Schwaag Serger et al. (2021). See also Qian (2024) for an analysis of China's research funding system and the effects of AI.

monitoring", "data analytics" and "search" for "reliable knowledge", together with the need for new evaluation and financing mechanisms, as well as more public and private investment in many regions of the world (including Europe), naturally, for frontier research, disruptive innovation and collaborative science/innovation;

ii) the **growing fragmentation of multilateralism** (i.e., the change of direction from globalisation to regionalisation), reinforced recently by recent North American policies, together with the defence and security of populations being considered notably and for the first time at political level in Europe as the priority factor for the competitiveness of its regions. It includes the discussion on the concept of *strategic autonomy*[36], with the growing relevance of space and information systems for defence and security, including, of course, energy and environmental security, public health, civil protection and the security of populations, as well as autonomy in the production of industrial and agri-food goods. But it also includes an in-depth discussion on "science and global geopolitics" and how Europe, among others (i.e., Latin America and Africa) will relate to the USA and China in the coming years;

iii) the **accelerated social and political polarisation of societies**, together with a relative weakening of democracies and the emergence of "me first" behaviours in a demographic context that is growing and changing[37]. This includes the need to prioritise young adults and better understand their ambitions, together with the challenges of attracting and retaining talented young people for science and innovation activities and the complexity of guaranteeing better jobs and research careers; and

iv) the **emerging societal challenges** associated with mental health, inequality in access to innovative biomedical treatments (especially for "non-curable diseases"[38]), as well as the destabilizing planetary pressures and inequalities of the Anthropocene, together with emerging environmental health challenges and the One-Health concept, as well as the search for comprehensive social transformations to alleviate these pressures in a demographic scenario that is growing on a global scale[39].

It is particularly noted that Ursula von der Leyen, President of the EU Commission, announced recently, a comprehensive proposal, "ReARM EU", enabling EU countries to increase their defence spending. In addition, the European Commission launched the concepts for a new "Union Strategy on Preparedness", as a political attempt to foster and unite European leaders towards an common secure strategy. Nevertheless, it remains to collectively understand how to translate the recommendations of Letta(2024), Draghi (2024) and Heitor (2024), mentioned above, for enhancing Europe's research impact into action.

36 > See, for example, https://www.europeanpapers.eu/europeanforum/strategic-autonomy-new-identity-eu-global-actor
37 > https://population.un.org/wpp/
38 > Ringborg, U. et al. (2024), "Strategies to decrease inequalities in cancer therapeutics/care and prevention - A Conference organized by the Pontifical Academy of Sciences (PAS) and the European Academy of Cancer Sciences (EACS)", Molecular Oncol., https://febs.onlinelibrary.wiley.com/doi/epdf/10.1002/1878-0261.13575
39 > https://population.un.org/wpp/.

The analysis in this paper is, therefore, geared towards discussing the conditions for stimulating "scientific activism" through doctoral education in close articulation with research and innovation. It will include considering the emergence of new positions on "Research Security" in the US[40] and Europe[41], as well as the analysis of the latest Human Development Report, which includes the slowdown in the promotion of greater equality between and within national states, as well as the unequal impact of Artificial Intelligence on a global scale[42].

The text aims to deepen the debate on the conditions for promoting new ideas on how doctoral education together with the defence and security of populations can be considered together with an inclusive and green transition in the emerging digital era, as well as contributing to eradicating poverty and reducing inequalities at local and global levels. It will necessarily include the debate on energy and environmental security, together with civil protection and public health.

Next section briefly describes main foreseen changes in Europe and section 3 discusses the challenge and the context for a new public financial framework at European level to better promoting doctoral education. Section 4 includes a final summary.

2. A proposal: *Align, Act and Accelerate* Research and Innovation

To address the emerging new complex of uncertainty, we all must consider three main foreseen changes in Europe, all of them strongly influencing doctoral education and research: i) the priority been given to **defence as the main driver of EU competitiveness**; ii) the need to **better engage young generations**, providing better jobs to guarantee a better future for them, together with *Choose Europe* to foster research careers in Europe; and iii) the need to take much more risks by **accepting failures as steps to success**. The following paragraphs briefly describe main implications of each of them.

2.1. The trend in the political debate at EU level is for **giving priority for "Defence as the main driver of EU competitiveness"** and this requires a continuous modernisation of doctoral education

This **should be associated with a better articulation of Research and Innovation (R&I) and doctoral education with the challenges Europe is facing**, with increased investments in R&I in a way to foster an increased growth layer of innovative companies.

Doctoral education and R&I are critical to strengthen EU *defence and security*, together with *Prevention, Preparedness and Readiness*, as well as *new solutions to society's climate, nature and biodiversity crisis*. But Europeans, at large, need coherent policies to strengthen supply chains across Europe focusing on high added value product and systems to "**escape the mid tech trap**" identified by the French Nobel laureate Jean Tirole and coworkers[43].

40 > See Jason (2024) "Safeguarding the Research Enterprise", Jason, May 2024.
41 > https://home-affairs.ec.europa.eu/policies/internal-security/innovation-and-security-research_en#related-documents
42 > https://hdr.undp.org/content/human-development-report-2025
43 > https://www.econpol.eu/publications/policy_report/eu-innovation-policy-how-to-escape-the-middle-technology-trap.

Our analysis suggests six main efforts to accomplish with this vision, as follows:

i. A revised and **strong Framework Programme for Research and Innovation** (i.e., FP10 for 2028-2034), with a portfolio of incentives, better articulated with all European Member States and Associated countries (i.e., UK, Nor, Swiss, Canada). It may be included in an overall "Competitiveness fund" but should be governed as a ***self-standing programme*** comprising a "**transformative agenda**" to address **four critical core "spheres" of action**, because of their structural interdependencies and interrelations: **i) Competitive excellence; ii) industrial competitiveness; iii) societal challenges; and iv) EU R&I ecosystem**. The "transformative agenda" should be launched in the short term, through specific actions in the last two years of Horizon Europe, 2025-2027, and embedded in the next EU framework Programme, 2028-2034. Articulation with Member States and Associated countries should be established through a better usage of "**Seals of Excellence**" and this requires radical changes in the operation of national funding agencies of research and innovation;

ii. Focus the Framework Programme for Research and Innovation, together with doctoral education, on **high added value product and systems to "escape the mid tech trap"** of Jean Tirole and coworkers. This includes advanced space and IT systems, among others, but it requires a **totally revisited governance model** for the Framework Programme, making use of the experience of ERC and EIC through independent governance councils;

iii. Launch and strengthen **public procurement at EU level**[44], providing a critical vehicle for Europe and Member States to stimulate demand for societally desirable solutions and at the same time promote competitiveness. This must complement and be effectively implemented in parallel to the Framework Programme for Research and Innovation to foster "European public purchases" of high added value product and systems (including those oriented for defence industries and security of European populations). Both the Letta Report[45] and the Political Guidelines for the Next Commission[46] point to the importance of making better use of public procurement as a driver of innovation;

iv. A revised **cohesion policy**, together with support schemes throughout entire Europe for doctoral education, in complement and in parallel to the Framework Programme for Research and Innovation, oriented to build supply chains of the defence and security industries throughout Europe. Requires radical changes in most European regional frameworks, which require continuous monitoring, assessment and review efforts throughout all Europe;

v. Consider doctoral education, together with research and innovation in the Framework Programme for Research and Innovation, as well as at national and regional levels, through a **nuanced, granular and revised global cooperation in science and technology**, with specific global partnerships and including actions with US and Chinese institutions, but also India, Brazil, Africa, and the Emirates, oriented to foster R&I strategic partnerships through Europe. It should be clear that the approach of the European Commission over the last decade is leading to an **excessive and costly deterioration in European scientific relations** with countries that are not fully or formally aligned with the European Union's interests or values. When such countries are becoming scientific and strategic markets, Europe cannot afford to adopt a simplistic or black and white approach. Comparisons between EU-China and EU-US S&T cooperation illustrate our point. While formal relations between the US and China are fraught with conflict and the rivalry between them, ideologically, militarily and technologically, defines our current era, the two countries continue to cooperate closely academically, and are each other's largest partners in internationally co-authored papers. Thus, **the share of US publications in science and engineering involving a co-author with a Chinese affiliation has grown from 7% in 2004 to 24% in 2022**. In comparison, in the same time period, the share of US publications involving a co-author with a UK affiliation has grown from 13% to 14% (NSF)[47]. Anyway, it is also important to keep in mind the work of Phillip Aghion showing the negative impact of US and CN researchers after the first Trump administration implemented the "China Shock Initiative", which was meant to "protect US intellectual property and technologies against Chinese Economic Espionage". Their research finds that "Chinese researchers with prior US collaborations reallocated away from US coauthors after the shock and also towards more basic research"[48];

vi. Consider doctoral education, together with the Framework Programme for Research and Innovation a **revisited approach to research security**, making use of a "project by project scheme", avoiding "blind" measures and overall top-down procedures.

In the discussion of these recommendations, it should be clear that "**dual use occurs naturally given the ubiquitous nature of modern technology** (e.g., AI, material science, the internet, drones) and the broad needs of a modern military (e.g., health, fitness)[49]. Instead, the European Commission and national agencies should administer programmes as "military RD&I" and "everything else" (i.e., civilian, dual use) and **optimise the innovation dividend** arising from the need for increased national security and defence expenditure by **exploiting dual use both ways**"[50]. See, for example, the recent EC´s Joint Research Council report on effective "**Defence Research and Innovation Ecosystem**" (i.e., EDRA – European Defence and Research Area[51]).

44 > See, for example, Edler (2019; 2023).
45 > Letta (2024).
46 > Ursula Von der Leyen (2024), "Europe´s Choice".

47 > https://www.cni.org/news/national-science-board-policy-brief-dramatic-changes-in-stem-landscape
48 > See details at https://www.college-de-france.fr/sites/default/files/media/document/2024-03/Does%20Chinese%20Research%20Hinge%20on%20US%20Coauthors.%20Evidence%20from%20the%20China%20Initiative.pdf
49 > See the Align, Act, Accelerate Report, Recommendation 12, https://op.europa.eu/en/publication-detail/-/publication/2f9fc221-86bb-11ef-a67d-01aa75ed71a1/language-en
50 > For example, US DARPA have and continue to fund significant health research, including in breast cancer, regenerative medicine ,vaccines and diagnostic tests, among many other areas.
51 > See European Commission: Joint Research Centre, SCHWAAG-SERGER, S., SOETE, L. and STIERNA, J., Scientific Report - For an Innovative, Sustainable and Fair Economy in Europe, Publications Office of the European Union, Luxembourg, 2024, https://data.europa.eu/doi/10.2760/0336180 https://publications.jrc.ec.europa.eu/repository/handle/JRC140513

Following the Nobel laureate Richard Feynman[52], the radical difference between "body of knowledge" derived from science, and the "application of that body of knowledge" requires an better understanding by European citizens, at large, and this clearly requires the continuous effort to **foster scientific culture** throughout Europe.

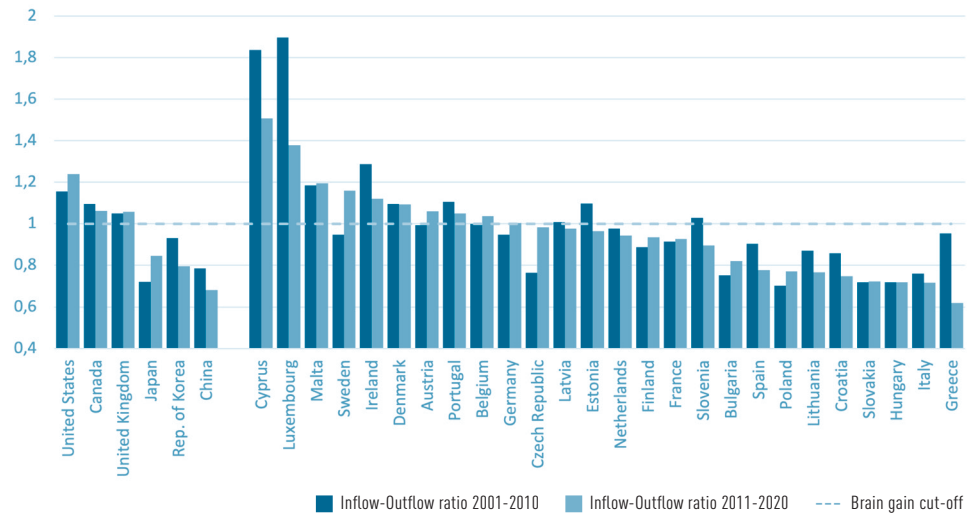
2.2. Engage young generations, modernising doctoral education and providing better jobs to guarantee a better future for them.

This is critically relevant at a generational and political levels with impact for all Europeans to face the rise of "populist" movements in Europe (and the world, as particularly stimulated by the new US administration and the Russian autocrats), including the support of many young adults. In addition, there is an opportunity for Europe to invest more on young generations, including for doctoral education, and to turn the current **"European Brain drain to the US" into an "European Brain gain"**. Figure 1 shows that during the period from 2001 to 2010, some member states including Germany, France, Sweden, the Netherlands, Belgium, and Finland experienced significant brain drain, mostly to the USA or UK. In the subsequent decade from 2011 to 2020, Sweden, Belgium and Germany have improved.

It requires continuously modernising doctoral education and increasing significantly the interaction between Academia, Research and Technology Organisations (i.e., RTOs) and enterprises, stimulating the exchanges among successive generations. It should consider launching **"Choose Europe"**, as a "pilot programme" already in 2025-27, making use of the existing MSCA- Marie Skolowsky Curie Actions cofund mechanisms to attract young talent researchers for European public and private institutions, through **better research careers**. The recent CESAER survey on Research Careers is very clear in this regard[53]. There is an urgent need to more intensively involve younger generations in research and innovation through better research careers. Educational institutions can play a significant role in educating them at all levels about the history and importance of democratic norms and values.

52 > See Feynman , R. (1998), "The Meaning of it All: Thoughts of a Citizen-Scientist".
53 > See https://www.cesaer.org/news/research-careers-a-critical-choice-for-europe-1850/

FIGURE 6 – Brain drain trends for EU member states and across the world, 2001-2020



Source: DG Research and Innovation – Common R&I Strategy and Foresight Service – Chief Economist Unit based on Science Metrix using Scopus database.

Note: The figure below documents European brain drain, through countries' brain drain in relative terms. A value below 1 implies that more researchers are leaving the country than entering it. While a value above 1 implies that the country has more researchers entering than leaving.

It should be noted that the ***European brain drain*** quantified in the figure is **occurring at the same time as an increase of the number of researchers in Europe**. There were 2.08 million researchers (in Full Time Equivalents - FTE) employed in the EU in 2022, which marked an increase of 648 000 when compared with 2012. They represent **about 2 % of the European labour force**. The number of researchers (FTE) significantly increased in Portugal and more than doubled in Poland, Sweden and Greece between 2012 and 2022. Most researchers (57%) are employed in the business sector, about one third of them (32%) in the academic sector, and 10% in the government sector. For comparison, in 2021, South Korea had the largest number of scientists and researchers per 1,000 FTE's, with 17.3 people working in research or science field per 1,000 employees. Sweden was second, with 16.6. The European average was 9.4.

However, the growth in the number of researchers in Europe has **not** been matched by an increase in the **quality of research jobs** and this has also driven brain drain. The need to address the **precarity many researchers now face** was explicitly addressed in the European Council conclusions of May 2021[54] on research careers and in the 'Pact for Research and Innovation' agreed in November 2021. The **Manifesto on early research careers**, published in September 2022 by the *Initiative for Science in Europe*, calls for urgent action[55].

54 > https://www.consilium.europa.eu/en/press/press-releases/2021/05/28/improving-conditions-for-research-careers-in-europe-council-adopts-conclusions/
55 > https://initiative-se.eu/2022/09/25/press-release-a-manifesto-for-early-career-researchers/

Analysis shows the need "to add to the current portfolio of excellent MSCA and ERC programmes by establishing a new ***Choose Europe*** instrument specifically focused on **outstanding young researchers** in, or following, their first postdoctoral position to enable them to rapidly become independent researchers. We believe that by **giving outstanding young researchers an early opportunity** to pursue their creative ideas, Europe will be internationally attractive and benefit from their presence and results".

Two research projects and consortia funded by the European Commission provide evidence on the evolving situation in Europe[56], underlining the **need for better data and for monitoring the quality of research careers**. Analysis has shown that the EU relies on an **unacceptable coupling between "project funding" and "contractual schemes"**, exacerbating precarity for young researchers and leading to diffuse (or even lack of) responsibility, at individual and institutional levels[57].

2.3. Take much more risks by accepting failures as steps to success in doctoral education and research.

We are facing a fast rate of technical change that requires **MUCH more disruptive innovation together with frontier research**. And this is absolutely **critical at the level of doctoral education.**

We certainly need to build on the experience of the European Research Council (ERC, since 2007) and the European Innovation Council (EIC, since 2021), together with strong "mission oriented collaborative research", but **experiment new ways to assess and fund R&D, with decreased time to funding, decreased transaction costs, and increased risks.**

And the action should start by creating an **"Experimental Unit"** under EIC[58]. **This must include:**

i. **assess, compare, experiment and foster new initiatives**, including for doctoral education and research, such as SPRIND in Germany and ARIA in UK, use advanced information systems and test new methods as those being experimented by many private foundations[59];

ii. **increase public expenditure on biomedical research and innovation, together with doctoral education**, to counterbalance the large increase in private expenditure and the resulting very high price of pharmaceutical;

iii. guarantee **more private expenditure with cofund mechanisms** in many other areas, including for greening of industry, together with new ways to guarantee food security at global level;

iv. **promote technology monitoring**, by promoting related **new tools and actors**, as well as strongly engaging the private sector in doctoral education.

56 > See details in RISIS, https://www.risis2.eu/2023/05/22/monitoring-and-analyzing-research-careers-for-informed-policy-making-in-the-era/; and SECURE, https://secureproject.eu/

57 > See details in Science Europe (2016).

58 > https://op.europa.eu/en/publication-detail/-/publication/2f9fc221-86bb-11ef-a67d-01aa75ed71a1/language-en

59 > See details in the Align, Act, Accelerate Report, Recommendation 4, https://op.europa.eu/en/publication-detail/-/publication/2f9fc221-86bb-11ef-a67d-01aa75ed71a1/language-en.

3. The challenge: *the context for a new public financial framework*

The three foreseen changes described above require a better understanding that EU can effectively act under threats, as demonstrated during the COVID-19 crisis, and use lessons learned from that period to develop again major financial instruments.

Still, and despite efforts and incremental improvements, **Europe exhibits an innovation deficit** when compared to the US and China, especially in critical and complex technologies. Turning research outcomes into business opportunities and the scaling up of innovative companies remains a challenge, with radical impact on doctoral education and research in Europe.

Our analysis clearly suggests that the need to spur public investment in Europe will require a new and revisited approach to ***need new European own resources***. To better understand the significance for Europeans, at large, to increase the research, development and innovation (RD&I) expenditure in Europe, analysis must follow OECD and Eurostat well established methodologies over the last 60 years, under which **research expenditure is mainly characterised by human resources related expenditures**, which account for about 90% of total expenditure[60]. Therefore, increasing the expenditure in RD&I in most European Member States and regions in the next decade is associated with attracting and retaining adequate concentrations of doctorate researchers, together with **three other critical issues:** i) Adequacy of **salary levels** throughout the labour force; ii) Modernising **research careers**; and iii) Considerable expansion, structuring and modernisation of **technical careers supporting RD&I activities** (i.e., S&T technicians and programme managers).

The **growth in the number of researchers** in many European Member States in recent decades occurs associated with a **relatively low expenditure per researcher** in many European Member States. For example, Slovenia and Portugal exhibit some of the highest growth rates in the number of researchers, reaching about 11 per thousand inhabitants in 2021 and similar to the concentration of researchers in Germany and Austria. But the disparity in salary levels and support staff leads to large differences in the levels of funding per researcher among those Member States.

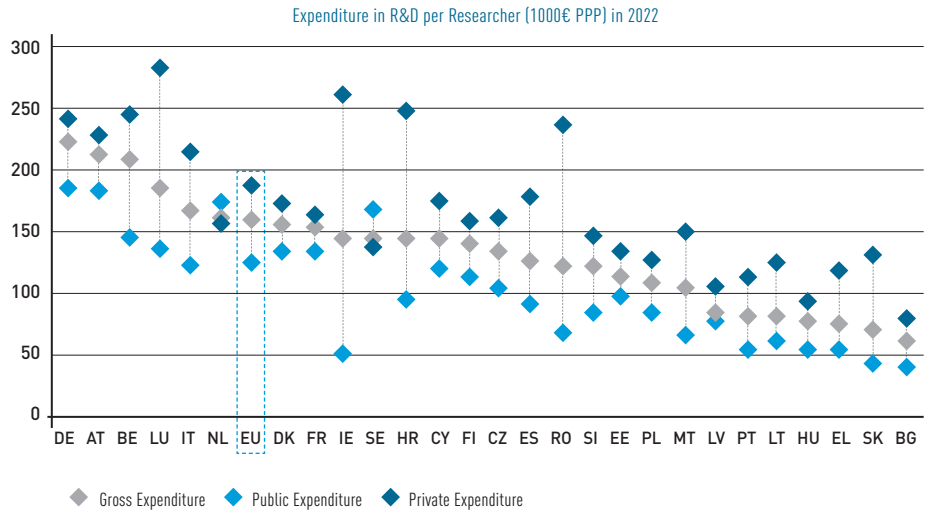
European Member States with the lowest RD&I expenditure per researcher are characterized by only one technician for every 4 to 5 researchers in 2022, Figure 2. This ratio is particularly low compared with the 1 technician for every 1.7 researchers in Germany and around 1 technician for every researcher in the US. The **lack of technical careers** over the last few decades in many MS and, above all, the **relative absence of research management careers** in many widening countries, has resulted in a growing inequality in professional support for research and innovation activities, with important consequences in terms of the intensity of expenditure per researcher.

It should be noted that, unlike in the US, where debt and procurement have been managed more flexibly over the last decades, **European investments in research and innovation have been hindered by stringent financial regulations. Moreover, funding is fragmented**;

60 > See details in the OECD's Frascati Manual, the internationally recognised methodology for collecting and using R&D statistics since 1964, with its sixth revision in 2015, as in: https://www.oecd.org/en/publications/2015/10/frascati-manual-2015_g1g57dcb.html

about 90% is nationally sourced, with only 10% coming from European sources. In addition, while the US mobilises 2.4% of its GDP for private financing of research and innovation initiatives, the EU manages only 1.2%. This had given a significant advantage to *American Ivy League universities* and tech companies. However, there is the need to carefully assess the situation across different knowledge areas, and, for example, we all need to better understand notable exceptions and the need to better balance private and public expenditure in R&D. For example, the situation in biomedical research (e.g., in "cancer pharmaceuticals" and other "non-curable diseases"), where the dominance of business expenditure in R&D has been implemented with unacceptable high prices for cancer pharmaceuticals, together with and increasingly high inequalities in the access to those pharma.

FIGURE 7 – R&D expenditure per Researcher in European member states in 2022
(PPP per researcher, corrected to 2005 prices)



Source: Eurostat (Data available in December 29, 2023)

4. Summary

Doctoral education in Europe must evolve in close articulation with research and innovation and in terms of emerging requirements to accelerate our collective response to geopolitical threats, boost innovation in defence and security, and rethink our understanding of "science for policy" in times of knowledge abundance.

Europeans, at large, are facing a fast pace of *technological change*, in times of *abundance of knowledge* at a global level, together with the rise of Chinese science. New and enlarged funding schemes, together with an continuously evolving doctoral education and research and new funding instruments are essential, inspired by models such as Germany's SPRIN-D and the UK's ARIA. Strengthening the *European Research Council* and establishing an Experimental Unit under the *European Innovation Council* could assess and test novel funding mechanisms, many already piloted by private foundations. It could also help attract more private investment through co-funding, especially in areas like industrial greening and food security. Additionally, it should develop effective tools for technology monitoring – a crucial capacity in times of rapid transformation – with strong private sector involvement. The aim is not to replace existing structures, but to complement them with agile, risk-tolerant approaches.

Doctoral education in Europe, together with research and innovation, must facilitate to escape the "mid-tech trap" by prioritising collaborative research and innovation towards **high added-value technologies** such as AI, space systems, advanced materials, quantum and robotics.

Strengthening and continuously modernising doctoral education in close articulation with *Research and Innovation* is absolutely required for a **stronger Europe**. It must consider an increased growth layer of innovative companies and RTOs making use of advanced ideas to strengthen EU defense and security, together with *Prevention, Preparedness and Readiness*, as well as new solutions to society's climate, nature and biodiversity crisis. This requires considering doctoral education together with an *European Research Alliance on Civilian Prevention, Preparedness and Readiness through Citizen Engagement*. But, above all, this needs new sources of financing and it is clear that "national budgets alone cannot bear the brunt of it. Therefore, we must build on the experience of *NextGenerationEU* and **guarantee new European *own resources*** by taking debt and accessing to capital markets.

Overall **opportunities are enormous for *"research intensive" doctoral education.***

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