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Chameleons

D1.1 Needs Analysis Report

WP1 Determining the Gap

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1. Introduction

CHAMELEONS overall aim is to develop a suite of modules for PhD and Post-Doctoral students which will involve interdisciplinary, intersectoral and international experiences. Work package 1 of the project sets out to determine the gap between what is currently available to these students to prepare for and offer exposure to such experiences, and what is actually needed. This deliverable, 1.1, is the first step towards this gap analysis. It identifies what is needed by early career researchers in order to prepare them for intersectoral and interdisciplinary research and careers.

There are three key elements to this needs analysis:

1. A systematic review of publications that identify and discuss the educational requirements of PhD and Post-doctoral graduates with particular attention directed to skills required or enhance the possibilities of graduates gaining employment beyond the academic sector.
2. Two surveys - of PhD and early postdoctoral students; and those involved in developing PhD modules - ascertaining their attitudes towards, and requirements from, courses/modules that offer and prepare them for cross-sectoral perspectives.
3. A review of policy and industry reports relating to doctoral education including EU policy documents, wider policy contributions across the EU, and industry-led reports from international consulting firms.

This report goes on to present each of these elements in detail.

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2.Part I: Systematic Review

Using a hybrid approach influenced by studies from Aguinis et al.[1] and Rhaiem and Amara[2], the systematic review aimed to examine academic literature surrounding the topic of interdisciplinary and intersectoral doctorate education in disciplines, particularly in areas related to Connected Health.

This review was intended to answer the following questions.

- What skills are desirable in doctoral graduates? Are these skills commonly found in these students?
- What benefits have been provided to doctoral students, universities and industry through interdisciplinary and/or intersectoral doctorate programmes?
- How have these benefits been provided? What were the challenges to their success?

2.1 Methodology

The following subheadings outline the steps and measures taken in order to ensure inferential reproducibility within the systematic review: (1) identification of sources, (2) a screening process to narrow results, (3) ensuring eligibility criteria is met and finally, (4) confirmation of sources to be reviewed in full. These are shortened to (1) identification, (2) screening, (3) eligibility and (4) inclusion, which can be viewed in *Diagrams 1, 2, 3, 4 and 5* in *Section 2.3*.

2.1.1 Inclusion and Exclusion Criteria

Before carrying out the review, it was decided that the scope of the study be determined based on four factors – time, field, type and audience (see *Table 1* below).

Table 1 (below)

Time Period	Field(s)	Types of Studies	Intended Reader Audience
2015-2020	Healthcare, Management, STEM, Education	Combination of qualitative and quantitative data, with emphasis placed on empirical studies	Academic researchers, educators, doctorate programme coordinators, industry collaborators, relevant governmental bodies
Recent articles were preferred, as studies show that the workplace is highly changing in recent years with	Connected health industries require collaboration from a	Empirical studies allowed for greater insight into real world examples.	This would ensure a level of professionalism in the literature.

[1] Aguinis, H., Ramani, R.S. and Alabduljader, N., 2018. What you see is what you get? Enhancing methodological transparency in management research. *Academy of Management Annals*, 12(1), pp.83-110.

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new demands for interdisciplinary and transferable skills lacking in modern workplaces related to connected health industries (*see Section 3).*	multitude of disciplines to deliver healthcare to patients.	

Four inclusion and exclusion criteria were additionally listed to further develop the standard for review. See table below for criteria and rationale, inspired by Rhaiem et al.[3]

Table 2 (below)

Inclusion criteria	**Rationale for choosing**
1. Articles in English language	All members of consortium could examine the documents
2. Peer reviewed journal articles	Information is trustworthy and comes from a reliable source
3. Discusses doctorate education	Document is relevant to the project
4. Discusses interdisciplinary doctorate education	Interdisciplinary doctorate education is most relevant to the project
5. Discusses intersectoral doctorate education	Intersectoral doctorate education is most relevant to the project
6. Discusses industry and societal concerns	Industry partners play an important role in the project's success and cannot be ignored
Exclusion criteria	
1. Unavailable in English language	Consortium could not read and discuss documents equally
2. Not a journal article – peer reviewed or otherwise	Information may be poorly researched and therefore unreliable
3. Is not relevant to doctorate education, even if interdisciplinary or intersectoral	Irrelevant to the project's objectives
4. Is not relevant to industry or larger societal issues	Irrelevant to the project's objectives

2.1.2. Search Strategy

[3] Rhaiem, K. and Amara, N., 2019. Learning from innovation failures: A systematic review of the literature and research agenda. *Review of Managerial Science*, pp.1-46.

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Two electronic databases were searched for this review, namely ProQuest and Scopus. Both databases contain literature from a range of disciplines to return mximum results and give insight into publishing trends across disciplines. The first Boolean search term used across both database searches was *"interdisciplinary" AND "doctora* education"* following a sequence of steps as outlined in *Figures 1* and *2* below.

Figure 1 : Scopus search: interdisciplinary AND doctora* education

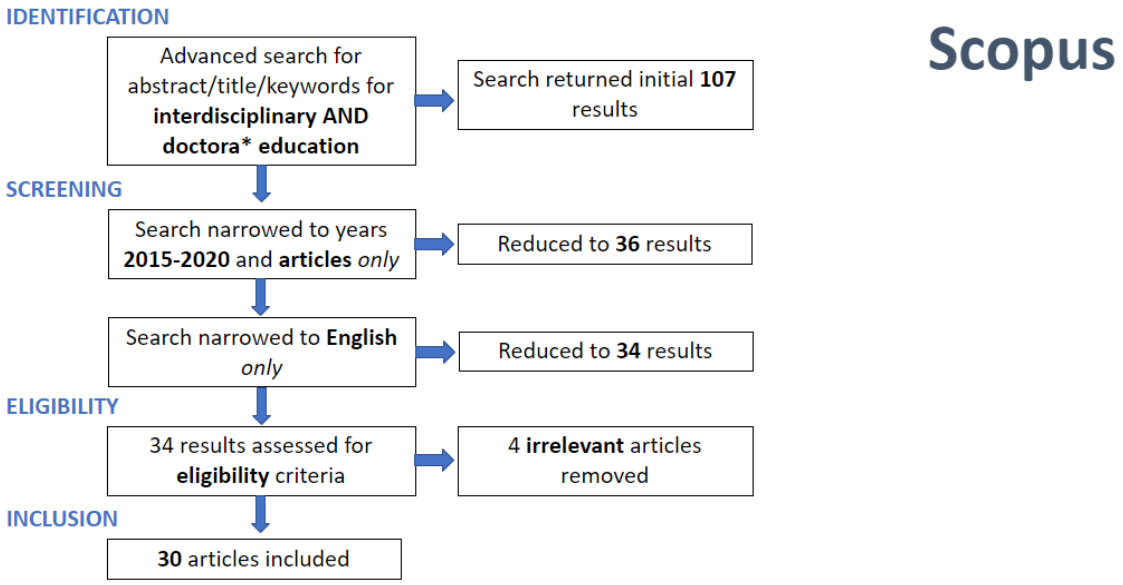
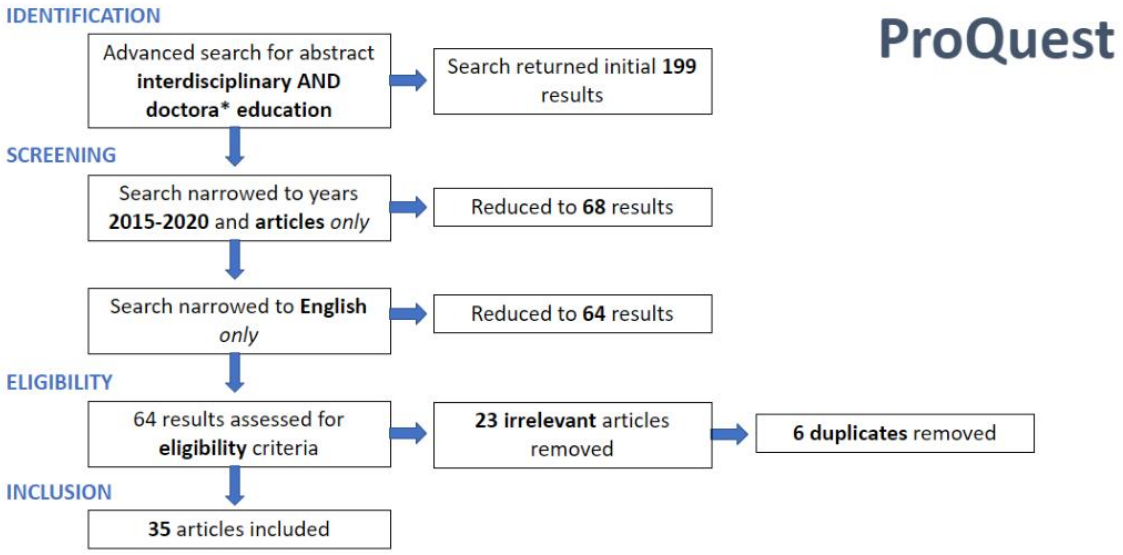


Figure 2: Proquest search: interdisciplinary AND doctora* education



Scopus returned an initial 107 results and ProQuest returned 199 respectively using "interdisciplinary" AND "doctora* education" for abstract searches. By sticking to the scope of research determined in *Table 1*, these search results were then narrowed to leave 34 Scopus articles and 64 ProQuest articles. Eligibility assessment was then done manually through reading the abstracts and introductions of each article. Through this,

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4 articles were eliminated on Scopus and left a total of 30 articles to be included in the review. A larger number of irrelevant results were removed from the list on ProQuest; 23 articles specifically. 6 duplicates were removed, leaving a total of 35 articles from ProQuest.

Bibliographies were then created for each database search following the screening and eligibility process and merged to create a 'combined bibliography'. A total of 65 articles were identified as part of this combined bibliography, with 7 of those then also eliminated as duplicates. An additional 9 articles were unavailable to access and so where possible, 7 requests for access were sent to the authors via ResearchGate. Two authors responded within the month of searching. However, this meant 7 articles were excluded and as of January 2021, 5 of those authors have yet to respond to the requests. This left a total of 51 but was reduced to 48 as further reading into the articles did not provide information relevant to the project and were then removed. This eventually left 48 articles for review following the interdisciplinary search.

In addition to this, another Boolean search term was then investigated for the second part of the study: "intersectoral" AND "doctora* education". It appeared that "intersectoral" was not a popular choice of phrasing within the literature (see figure 3 below). This search term did not return *any* results on ProQuest, so it was then decided to try a more commonly-used term instead to ensure relevant studies were not left out. This led to the third abstract search, "university industry collaboration" and "doctora* education". The number of articles from this search were still small in comparison to interdisciplinary research, only making up approximately 24% of the final article review list when passing all stages of the source selection process. This is a trend to be discussed further in *Section 2.4*.

Figure 3: Scopus search: intersectoral AND doctora* education

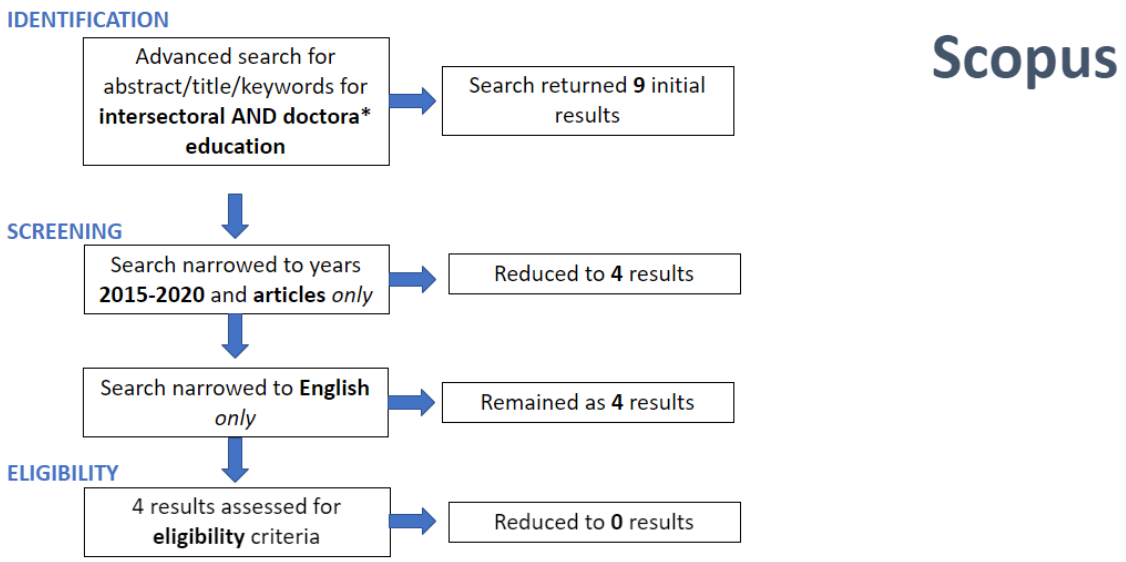

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Figure 4: Scopus search: university industry collaboration AND doctora* education

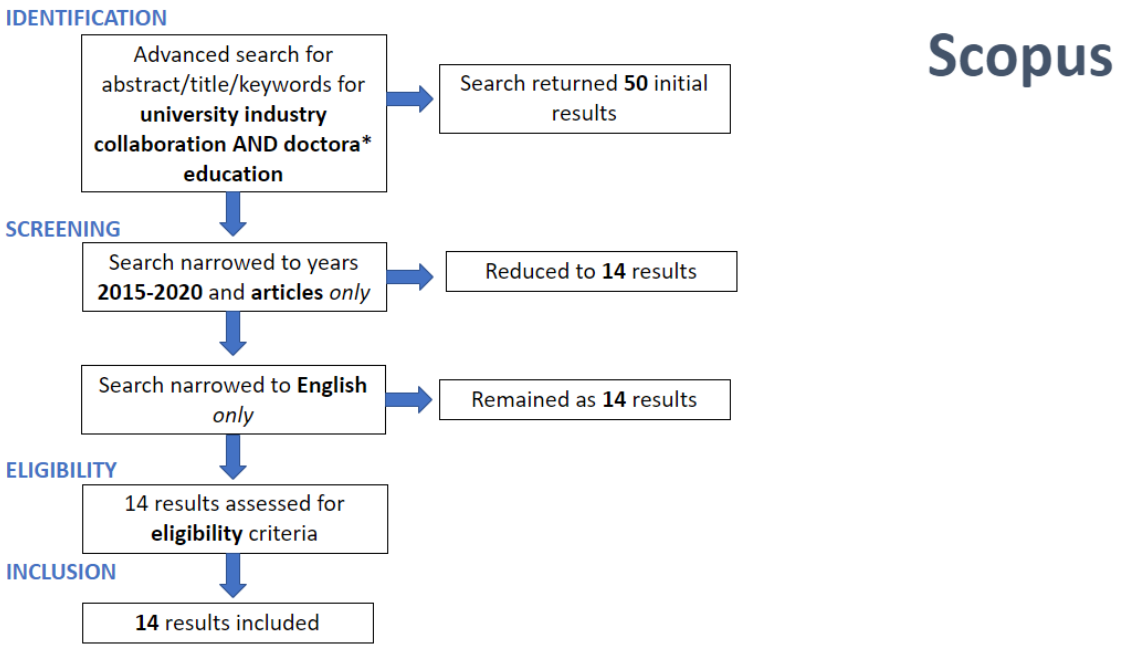
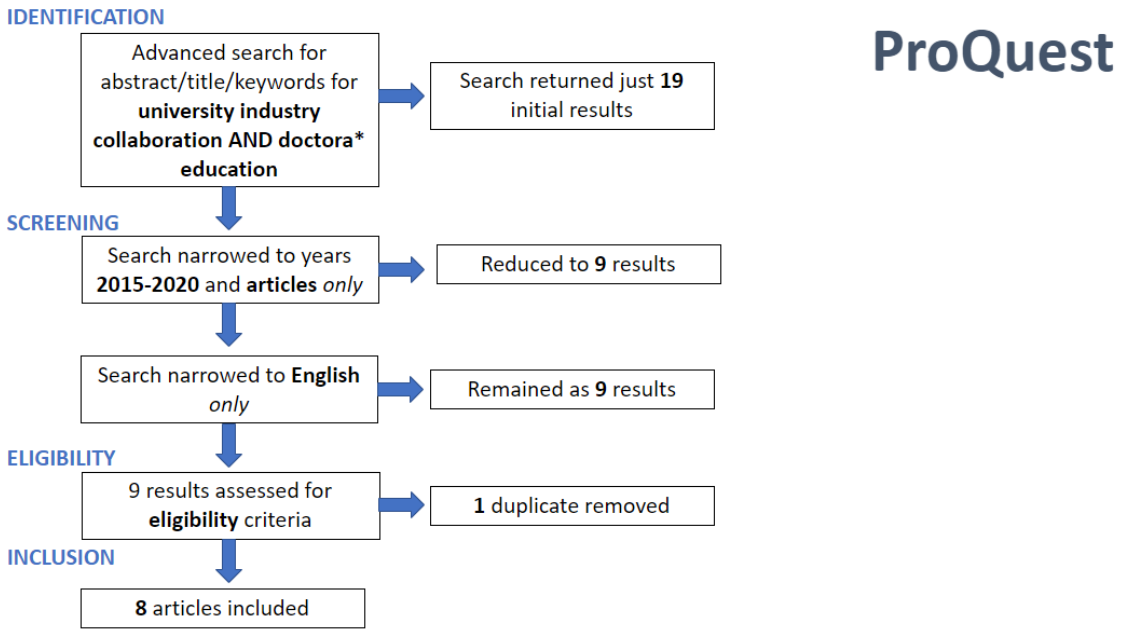


Figure 5: ProQuest search: university industry collaboration AND doctora* education



Following these two searches, another combined bibliography was created. Five duplicates were then removed, further reducing the number of articles from 22 to 17. Another article was removed due to the inability to gain access, leaving the total of university industry collaboration search results to 16 articles, which were then added to the previous list to form an ultimate bibliography. An additional article lacked useful information upon reading and resulted in no coding, which reduced the university industry collaboration bibliography to 15 articles. This made for a combined **total of 63 articles for review**.

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All academic database searches were conducted between the end of October to the end of November 2020. The authors read and discussed each article's abstract during the eligibility stage of the process, eliminating articles deemed irrelevant to the study. The second author had previously published research in the area of Connected Health and doctorate education, which added credibility to the articles remaining for review.

Using the Gioia method[4], the authors took an inductive approach to analysing the articles. This was done using the qualitative data analysis software NVivo, where first order codes were created after spotting recurring themes in the literature that related back to the research question and objectives of the needs analysis. Second order codes were also created to provide further analysis into the existing themes and find connections between codes where relationships between data could be examined in more depth. This reflected a grounded theory approach[5] and will become more evident in *Section 3*.

2.2. Characteristics of the Data

Approximately 57% of the articles were published in education journals, though there were also publications in healthcare (14.3%), STEM (14.3%), management (9.5%) and other/multidisciplinary journals (6.35%). This suggests that much research into interdisciplinary and intersectoral doctorate education has focused largely on the educational perspective with the student at the center of the research. This is a point to be explored further in *Section 3*. See *Tables 3, 4, 5, 6 and 7* below for more detail on the breakdown of journals and research fields.

2.3. Findings

Findings suggest that today, the world runs on the Knowledge Economy whereby the market is no longer driven by material goods but instead unique knowledge and skills to capitalize and innovate on (Celis and Acosta, 2016). Governmental bodies such as the European Union recognize this and have set out strategies to increase competitiveness in the global market, such as the Lisbon Strategy (Haapakorpi, 2017). In turn, this increased demand for higher educational attainment in many workplaces is prompting a shift in doctoral education (Santos et al., 2020). This is especially of concern to those involved in the Connected Health industry, which is responsible for a large portion of society's wellbeing and is only continuing to grow with the advancement of technology today (Chouvarda et al., 2019). Beyond technology development, however, the Connected Health industry requires a much broader set of knowledge and perspectives in order to truly understand help patients. It is not isolated in its requirements - several other industries today favour well-rounded graduates over specialists.

[4] Gehman, J., Glaser, V.L., Eisenhardt, K.M., Gioia, D., Langley, A. and Corley, K.G., 2018. Finding theory–method fit: A comparison of three qualitative approaches to theory building. *Journal of Management Inquiry*, *27*(3), pp.284-300.

[5] Timmermans, S. and Tavory, I., 2012. Theory construction in qualitative research: From grounded theory to abductive analysis. *Sociological theory*, *30*(3), pp.167-186.

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Traditionally, a PhD is considered the highest form of educational attainment and is research-intensive in nature. However, this has conflicted with the demands made of doctorate graduates in the 21st century. Graduate students may not, however, have the skills and knowledge required in many industries, particularly in engineering, healthcare and the physical sciences (Cui and Harshman, 2020; Lieu Tran et al., 2019). Moreover, overskilled and overspecialised doctorate graduates have shown decreased job satisfaction and earnings (Germain-Alamartine and Moghadam-Saman, 2020). This highlights an important issue surrounding doctoral education and what benefits it is providing to students and employers alike.

As such, doctoral programmes have been revised in recent years to solve this issue of overspecialisation and lack of real-world engagement. This has come in two forms; interdisciplinary programmes or intersectoral programmes.

The first solution to fixing doctoral education comes in the form of interdisciplinary programmes. The term interdisciplinary itself can be used loosely in the literature and often confused with other similar concepts such as multidisciplinary, transdisciplinary unidisciplinary. Therefore, we will follow the definition provided by Kemp and Nurius which explains that "scholars work jointly on a common problem with the intention of transferring knowledge from one discipline to another" (2015: 134). Therefore, collaboration plays a big role in interdisciplinary programmes and is often accredited to its success or failure dependent on how it is fostered throughout the programme. It differs from the traditional isolation of the student within doctoral education and so requires careful thought into how best to plan such a programme (Balleisen et al., 2018).

Teamwork is common within interdisciplinary programmes, though they vary in how they are operated. Most commonly, teams will be created of researchers from various disciplinary backgrounds in order to gain experience directly working with those outside the researcher's main discipline and learn to appreciate different epistemologies that they may later use in their own work (Bosque Perez et al., 2016; Patricio and Santos, 2019). Interestingly, students have reported that having access to different perspectives was actually of greater value than gaining personal direct personal knowledge of the subjects (Mountford et al., 2019).

This compliments other opinions on the matter, such as developing shield-shaped competency with depth in their own research area whilst wielding breadth of knowledge in other disciplines and research methods (Bosque Perez et al., 2016). As Holt put it, "[i]t is more valuable to gain the necessary communication and collaborative skill set to be able to work in an interdisciplinary manner when needed" (Holt et al., 2017: 128). The importance of communication and teamwork skills are discussed in more detail in section 2.3.2 below.

It is also worth noting though that these studies raise a question of whether interdisciplinary doctorate programmes are truly intended to produce well-rounded talent for industry or for academia, given the focus on measuring publications – a known source of assessing academic success – and how interdisciplinary or co-

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authored works are still frowned upon by academic communities (Holt et al., 2017; Rohwer, 2015). This is an issue further discussed in *Section 2.3.8*.

A second solution involves intersectoral doctoral education. One of the best ways to create these networks between universities and industry, students and employers, is to engage directly with industry partners in an intersectoral programme. While the word intersectoral is not often used in the literature, university-industry collaboration is common. Several theories explore the triangular relationship that exists between universities, industry and government, also known as the Triple Helix model (Roberts, 2018; Salimi et al., 2015). The Triple Helix model is often used when discussing knowledge transfer, which is attractive to industry partners and students alike (Patricio and Santos, 2019). Governments also see the value in intersectoral collaboration between academia and industry. The Taiwanese Ministry of Education, for example, produced a white paper encouraging graduate research institutes to engage with organisations and promote industrial growth (Weng and Chang, 2016).

The most popular form of intersectoral doctoral education is industrial PhDs that revolve around the transfer of knowledge between academics and practitioners. Typically, these types of programmes involve the student working directly within the non-academic organization for a period of time, with the expectation that the student will then use their resources and research skills to provide a solution. In turn, the organization will provide hands-on training which can help develop more transferable skills in the student (Cardoso et al., 2019; Celis and Acosta, 2016; Germain-Alamartine and Moghadam-Saman, 2020). Additionally, their personal presence within the organization and regular contact with employers and employees can create strong interpersonal connections with members of the organization and therefore build their professional network. Students also reported being more self-driven following their industry placement (Sense, 2016). All of these outcomes make it much easier for the student to then transfer to industry following completion of their studies (Kunttu et al., 2018). Benefits are provided to universities also as students then bring back practical knowledge into their research (Cardoso et al., 2019).

The following subheadings examine the literature in order to generate better insight into student, staff, and employer needs and considerations with regard to both intersectoral and interdisciplinary doctorate education programmes.

2.3.1 Transferable skills

Transferable skills refer to generic skills that can be applied to almost any career as they range from communication, flexibility, leadership, teamwork, planning, organisation, management, and problem solving (Cui and Harshman, 2020; Germain-Alamartine and Moghadam-Saman, 2020; Kitchin, 2015; Patterson et al., 2019). Debate exists between what is considered a generic or transferrable skill in each discipline and so interdisciplinary programmes may see conflict between members in what is considered a useful, generic skill. This possible conflict is discussed further in *Section 3.8* alongside its possible resolution through improved communication. We define transferable skills

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as those that can be applied across disciplinary and professional boundaries (Haapakorpi, 2017).

Although such 'Soft skills' are highly sought after, little attention is given to their development within traditional doctorate programmes (Cui and Harshman, 2020; Donina et al., 2017; Germain-Alamartine and Moghadam-Saman, 2020; Slota et al., 2018). Employers have demanded that there be a change in the curriculum to address the mismatch between the needs of industry workplaces and the skills developed during doctoral programmes (Cardoso et al., 2019; Germain-Alamartine and Moghadam-Saman, 2020). Change has occurred as a result, with doctorate programmes now addressing the issue of transferable skills and graduate's employability (Patricio and Santos, 2019; Santos et al., 2020).

2.3.2 Opportunities for interaction

Communication is considered one of the most key transferable skills to any career yet challenges can come with it's development when in an interdisciplinary environment. Not only is the ability to communicate with other fields desirable, but also having a broad understanding of other disciplines overall and being able to understand their viewpoints (Bosque Perez et al., 2016; Carr et al., 2018; Cui and Harshman, 2020). It can be easy to misinterpret others with whom we do not share a common goal or value, which is why communication plays a large role in interdisciplinary teamwork and projects. Identifying a shared vision has proven valuable to interdisciplinary teams as they bring members closer together and broaden the researchers' perspectives (Bosque Perez et al., 2016). Likewise, it can be beneficial for individual students to see how their own work can benefit other disciplines and identify their own opportunities for collaboration (Kiley and Halliday, 2019). Thus, communication skills benefit both the individual and the team's chances of success.

Methods of fostering communication skills in these programmes range from specific curricula activities to informal interaction opportunities. Touching on the former, examples include seminars for students to share research ideas and methods and mini presentations (Kiley and Halliday, 2019). In terms of informal opportunities for interaction, examples include group meals on and off campus (Balleisen et al., 2018; Caliskan and Holley, 2017; Kiley and Halliday, 2019). Informal interactions were found to be especially useful as they allowed for open discussion without fear of judgement from peers due to their relaxed nature (Kiley and Halliday, 2019). These interactions can result in building trust and respect, both of which can have positive effects on individual and team personal and professional development (Carr et al., 2018). These peer-to-peer interactions have been shown to be most effective in the development of interpersonal skills (Holt at el., 2017). When students feel relaxed with each other, it makes for a more creative, open-minded discussion and collaboration environment (Chouvarda et al., 2019). Ideally, a programme wishing to foster collaboration between students would prioritise both formal and informal interaction opportunities to develop the students' own personal and collective skills (Caliskan and Holley, 2017).

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Communication can come in multiple forms and different authors emphasise different aspects. Written communication skills tend to be favoured by academics while oral communication skills are emphasised by industry (Cui and Harshman, 2020). Therefore, students of different backgrounds may prefer different types of communication, providing yet another challenge to interdisciplinary programme planning. One method of communication is, however, consistent in its reception by interdisciplinary students regardless of background. Digital communication has been proven to have both positive and negative consequences when used in doctorate programmes. Blogs and social media groups for students to keep in touch and share information were beneficial (Balleisen et al., 2018; Mountford et al., 2019). However, online interactions did not provide the same level of rapport as face-to-face communication. These face-to-face interactions are particularly crucial to collaboration (Carr et al., 2018). Therefore, a lack of physical presence in collaboration has led to decreasing quality of relationships and trust, alongside reduced networking opportunities (Carr et al., 2018).

2.3.3 Networking

Networking is particularly important to doctoral students, with both their peers and respected seniors (Pammer-Schindler, 2020). Networking provides students with academic and career opportunities for the future as social capital ('who' you know) becomes valuable in securing jobs quickly. Moreover, networking with researchers outside their home discipline can aid in identifying collaborative prospects, further strengthened by the development of their communication and teamwork skills. Mentors and supervisors also provided access to networks as well as strengthening their own relationship with the student for years to come (Caliskan and Holley, 2017).

Networking is not only important for the students but for industry organisations as well; strong ties with universities grant industry access to talented researchers who may be able to provide them with answers to problems within their organisation (Gustavsson et al., 2016). Therefore, it is in everyone's best interest to pay attention to the need for networking opportunities, as well as to where and how they can be provided.

2.3.4 Supervision and mentoring

One of the key figures in any doctoral student's journey is their mentor or supervisor. They are usually their first point of contact when it comes to their work or any questions they may have. Given the relationship involved, it is unsurprising that mentors and supervisors can also affect the researcher's own perception of what makes for effective leadership (Hammel et al., 2015). As such, mentors have great influence over their student's lenses of their work and the world around them. Due to the collaborative nature of interdisciplinary and intersectoral doctoral programmes though, complications can arise in this area.

More often than not, doctorate students in both interdisciplinary or intersectoral programmes will have two or more supervisors (Anne L van et al., 2015; Bosque Perez et al., 2016; Carr et al., 2018). This is so that a student's

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research plan is scrutinised from two or more different perspectives (Anne L van et al., 2015). This is modelled regularly in Germany also, where a thesis advisory committee is built of faculty from a variety of disciplines to ensure diversity in feedback (Qin, 2017). Intersectoral programmes usually opt to have the second supervisor in the industry organization itself, further displaying the connection of the Triple Helix model and relationships involved in such programmes.

Some programmes will have a professional supervisor in addition to a peer mentor (Caliskan and Holley, 2017). In the past, mentors have been chosen on the basis of similarity to the student with factors such as academic discipline, gender, race and ethnicity, though these factors can all be preferenced by the students themselves (Caliskan and Holley, 2017). For example, a female student could request she was given a female mentor. Supervisors and mentors play similar roles though the mentor will usually hold a more informal type of relationship with the student. Students themselves could take on mentorship roles to undergraduates if they wanted to, providing them with opportunities to develop professionally (Dasgupta et al., 2015).

Some of the literature does not draw such lines between supervisor and mentor and will use the terms near identically. For example, the following quote uses mentor yet describes what is typically expected of a supervisory role in other literature: “each fellow is matched with an individual faculty mentor who guides reflection, helps set goals, and recommends readings that can help connect the clinical experiences with research interests. The faculty mentor is responsible for providing regular narrative feedback on the scholar's written work to help develop the scholar's critical thinking. Grading for the academic course component of the fellowship is based on a combination of written assignments and feedback from clinical supervisors on the scholar's clinical development, performance, and professionalism” (Greene et al., 2017: 284).

Busy schedules and lack of personal fit were found to be negative influences on the relationship between students and mentors (Caliskan and Holley, 2017). Supervisors have mentioned concerns for handling students with different backgrounds to themselves, with worries surrounding whether they can handle a student that may go in a direction they are not familiar with (Brand, 2020). Suggestions have been made that a faculty training programme be introduced to better prepare supervisors for working with others in interdisciplinary or intersectoral contexts (Bosque-Pérez et al., 2016). Ideal supervisory traits include open-mindedness, curiosity and being receptive to having their own biases challenged (Kiley and Halliday, 2019).

2.3.5 Supportive research and organisational cultures

Biases often stem from long engrained research cultures within various disciplines. These research and organisational cultures can be traced back to the role of universities within societies. Traditionally, universities were seen as a place of education and research despite more modern demands for them to take on an additional role as contributors to economic development (Cardoso et al., 2019; Haapakorpi, 2017; Patricio and Santos, 2019; Salimi et al., 2015). “The Triple Helix model recognizes universities as not being limited merely to providing education and conducting research but, rather, as

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having a wider role which includes generating and attracting talent and facilitating innovation, entrepreneurship and industrial competitiveness" (Gustavsson et al., 2017: 41).

Research cultures can be described as the set of beliefs, norms, and values that exist within a particular discipline or research institution (Kunttu et al., 2018). The transferable skills discussed in *Section 3.2* are not often recognized as core to STEM subjects and seen as complimentary but by no means necessary despite the literature saying otherwise (Kiley and Halliday, 2019). In Connected Health particularly, each healthcare profession has its own culture which makes interdisciplinary work particularly challenging as some disciplines outright reject certain creative methods that other disciplines may prefer (Chouvarda et al., 2019). Conflict is a common issue in interdisciplinary programmes, which is why transferable skills such as communication and open-mindedness are so important in dealing with them effectively as they as generally unavoidable (Bosque-Pérez et al., 2016; Franco and DeLuca, 2019).

On a positive note, there have been examples of success in challenging research cultures biases in interdisciplinary doctoral programmes. Students have been openly asked to discuss both the strengths and weaknesses of their main research discipline as a class activity, which helped them to appreciate the uses of various epistemologies and methodologies from others (Carr et al., 2018). Self-reflective surveys were also issued during a seminar titled 'Philosophical Issues in Interdisciplinary Research' to challenge students to think critically about their assumptions going into the course (Bosque-Pérez et al., 2016). Another example includes a workshop titled 'Finding our way: interprofessional connected health education' that directly asked students to think ahead about what barriers or misunderstandings may occur in their interdisciplinary work and how might they overcome them (Chouvarda et al., 2019). Humility and respect are the keys to success here in breaking down the barriers of research cultures (Carr et al., 2018).

It is not just students who must learn to respect and listen to each other, faculty should do likewise (Cebrián, 2018). Organisational structures in universities typically separate disciplines into different departments with little encouragement or effort made to develop communication across departments, leading to knowledge separation and segregation rather than integration (Donina et al., 2017). This organisational structure is also a challenge for students with supervisors from different disciplines. They may find themselves dealing with conflicting feedback, having to choose who to please with their work giving rise to concern as to whether or not they will be taken seriously (Lindvig, 2018). Universities as a whole must learn to reward interdisciplinary work as much as disciplinary work, given their history of giving quicker graduation and promotion to the latter (Golembiewskih et al., 2018). Collaboration is not always welcomed either as authors with many co-authored publications can be viewed distastefully within academic communities (Rohwer, 2015).

Location and environment are not usually touched upon in the literature but are still worth noting as influencing factors in interdisciplinary and intersectoral doctorate programmes. Depending on the country, third-level educational institutions may be

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divided into different categories with various definitions of what a university is or can be. Depending on the type of institution, the organizational culture may differ and further differences arise between disciplines. Organisational culture is usually deeply held and as such, is not expected to change overnight (Price et al., 2019: 316). It can also be hard for students in intersectoral programmes to fit in quickly at their industry placement due to the new organizational culture and behaviour expected of them compared with their academic responsibilities and environment (Santos et al., 2019).

Doctorate students whose research is developed solely within their university will have their attitudes shaped solely by their supervisors and the organisational culture, which may limit their perspectives and identification of opportunities outside the institution (Holley, 2018; Roberts, 2018). This is one of the main issues identified with traditional doctoral programmes as they reduce the student's awareness of their own capabilities and lack confidence in their professional identity.

2.3.6 Professional and personal identity

"The doctoral degree is considered to be a reflection of a disciplinary identity" (Holley, 2015: 642). These questions of identity often manifest into difficulties identifying one's own capabilities and how to market themselves (Anne L van et al., 2017; Holley, 2018; Roberts, 2018). It is not uncommon for interdisciplinary students in particular to enter post-doctorate programmes despite the aims of their doctorate programmes typically being to prepare the students for industry careers (Holley, 2018). This is an issue that must be addressed when planning the course outline and curriculum for the doctorate programmes to ensure that students' professional identities are nourished. Due to the nature of such interdisciplinary and intersectoral programmes, the researcher's individuality should be treated with respect and give the student the power to self-direct their learning and choose how and when to access particular knowledge (Roberts, 2018).

Though not common, modules have been implemented in past interdisciplinary doctoral programmes to help students develop their professional identity. One such example is a Career Exploration course that developed students' confidence to explore career options. Students learned the value that their skills and knowledge brought to careers they may later enter, tracked through individual development plans (Urizar et al., 2017)

Identity is not just in relation to career paths though, it also directly influences a student's sense of belonging (Caliskan and Holley, 2017; Qin, 2017). In an interdisciplinary environment where boundaries are broken down, this is an especially important consideration as it will affect the student throughout and beyond the programme. Opportunities for informal interaction are shown to be useful here as the relaxed nature of peer-to-peer engagement builds community and solidifies this sense of belonging within their programme (Bosque-Pérez et al., 2016; Caliskan and Holley, 2018; Kiley and Halliday, 2019). These two often go hand-in-hand; "doctoral programs should focus on identity development and socialization to enable emergent interdisciplinary scholars to develop strong connections with multiple communities that align with their emergent professional identities" (Holley, 2018: 124). Building a strong research community within interdisciplinary programmes is key, as doing so in the past

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improved confidence and created a sense of belonging for students who previously felt isolated (Caliskan and Holley, 2017; Kiley and Halliday, 2018).

2.4 Summary

In summary then, key concerns in the development of doctoral education programmes that will meet the needs of both students and potential employers in industry and academia are the development of transferrable skills; the creation of formal and informal opportunities for interaction and networking; thoughtful and integrated supervision and mentoring; the development of supportive research cultures at departmental and university levels; and the nurturing of strong, boundary spanning professional and personal identities.

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3. Part II: Surveys

The overall aim of CHAMELONS is to develop a range of interdisciplinary, inter-sectoral and international modules which are designed to broaden the skills of PhD graduates and improve their employability in academic and non-academic environments. The purpose of this research is intended to improve the skills and attributes of Ph.D./Postdoctoral students so that they will have increased employment opportunities on completion of their studies. To that end, two surveys were undertaken across the consortium to gain the views of those who take such courses (young researchers) and those who design and implement such courses (Programme Directos or equivalent). The results of these survey aim to identify the impact of these courses on future career challenges, determine gaps and use this information to develop innovative educational interventions.

3.1 Methodology

The focus of both questionnaires was on intersectorally designed/delivered modules which are available to PhD/Postdoctoral students.

3.2.1 Participants

The participants of this survey were divided in two target groups:

- Young researchers: In this category PhD & Postdoc students were included. The inclusion criteria were: (i) the participants should be currently PhD candidates or (ii) they have finished their PhD in the past 5 years.
- Research associates/ program directors

As stated in the initial proposal, participants were approached by consortium members. The survey was completely anonymous, so no information can lead back to a specific participant. The on-line survey link was sent by the partners among their professional networks.

3.2.2 Survey Development

Two different questionnaires were developed, one per target group, since the interest is different for the cases that a participant is an attendant or a creator of a course. Although the focus for retrieving the desirable information was the same.

The survey was iteratively designed with the participation of AUTH, OULU, UCD and Maynooth partners. After an initial workshop, the questions were proposed and reviewed/refined by the partners, to decrease redundancy and increase clarity. In a second stage the questionnaire was implemented in the platform and internally reviewed before final deployment.

To achieve the goals of the project the questionnaires are divided into two categories: (i) General Questions and (ii) Course-specific Questions.

In the first category, the questions focus on demographic characteristics of the participants and on attaining general information regarding the courses that they may have taken/directed during their studies/work. The interest here lies in the nature of

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the courses and specifically what percentage of them are internal or external, intersectoral or not, interdisciplinary or not.

In the second category, the participants were asked if they have taken/directed a specific course that was useful in terms of broadening students' career prospects outside Academia. For this specific course, the participants were asked to answer to some questions which are divided into three subcategories: (i) Nature of the course: to obtain general information about the specific course (title, content etc.) and the nature of the course (internal/external, intersectoral/not, interdisciplinary/not), (ii) Satisfaction: to obtain information about the satisfaction of the participant regarding the specific course, (iii) Structure: to obtain information about the structure of the course (duration, interaction level, grading, etc.).

The questionnaires were developed using the online survey tool LimeSurvey1. A central installation of the tool is provided by AUTH. All processes are GDPR compliant, and the questionnaires were developed after the consultation with AUTH's DPO and after the approval of AUTH's ethical committee. The survey was completely anonymous, no personal information was asked from the participants and no communication information was stored or kept. The answers are safely stored in a database inside AUTH's infrastructure, inheriting its safety and security protocols, and cannot in any way lead back to the participants.

3.2.3 Ethics and Consent

Ethical approval for this survey was sought and received from AUTH university Ethics Board. All participants were requirement to agree to a consent form before completing the survey. A copy of this consent form is included in Appendix I of this report.

3.2 Results

Fifty young researchers completed a questionnaire while 8 more senior academics who were involved in the development or design of PhD modules took part.

3.2.1 Young Researchers

40% of the young researchers were male and 60% female. The majority proved to be more mature, with all but three aged over 25 years and 62% over the age of 30. Respondents came from a wide range of disciplinary backgrounds including biology, business, education, engineering, environment, health, Information and Communication Technologies (ICTs). Engineering, health and ICT were the most common pre-PhD study areas accounting for 28 out of the 50 respondents. As might be expected, the areas of PhD study proved more dispersed as respondents specialised in niche areas (see Table 2.1 below). Half of respondents had commenced their PhD studies in the past three years. While there are as many reasons to do a PhD as there are students undertaking them, some common themes emerged across the student respondents as to what had driven them to undertake a PhD programme: from a personal enjoyment of research (80%) to a desire to improve their academic skills (56 %) to an intention to enhance their career prospects (48%). The majority of students (66%) saw themselves in the future remaining within academia from a career path perspective.

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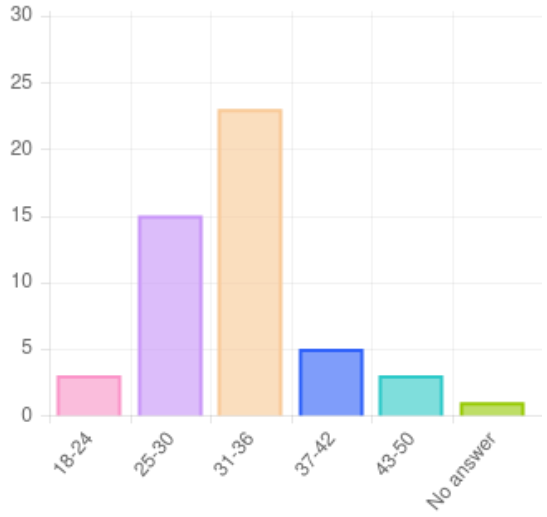

Figure 1: Age profile of respondents

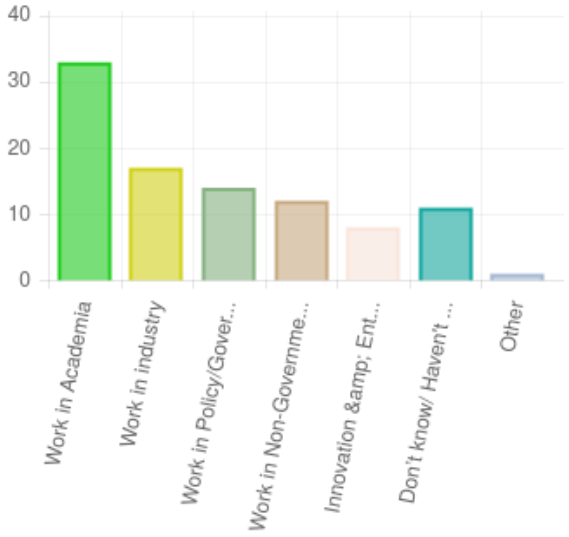

Figure 2: Career plans

Table 2: 1. Area of your Ph.D. studies

Answer	Count	Percentage
Education science	4	8.00%
Audio-visual techniques and media production	1	2.00%
Management and administration	4	8.00%
Marketing and advertising	1	2.00%
Biology	2	4.00%
Natural environments and wildlife	3	6.00%
Earth sciences	1	2.00%
Computers use	1	2.00%
Software and applications development and analysis	1	2.00%
Information and Communication	3	6.00%
Inter-disciplinary programmes and qualifications involving Information and Communication Technologies (ICTs)	5	10.00%
Chemical engineering and processes	2	4.00%
Environmental protection technology	1	2.10%
Electricity and energy	4	8.00%
Electronics and automation	1	2.00%
Medicine	3	6.00%
Medical diagnostic and treatment technology	2	4.00%
Therapy and rehabilitation	2	4.00%
Inter-disciplinary programs and qualifications involving health and welfare	1	2.00%
Sports	1	2.00%
Other	7	14.00%

A clear majority of students (84%) had participated in courses or learning activities while completing their PhD. 71% completed courses internal to their PhD programme while 86% completed courses external to their programmes such as seminars, conferences, or summer schools.

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Of the internal courses undertaken by our student respondents, 40% of these included involvement from non-academic tutors or speakers. For the most part this took the form of guest speakers (92%) although guest speakers also took an active teaching role as tutors in 50% of cases. Non academic involvement also took the form of site visits (33%) and the provision of live case studies (25%). The disciplines from which these non academics were drawn were widely dispersed and included technical, social and managerial sciences (see table 4 below for more detail).

Table 3: Role of non academics in PhD training

Answer	Count	Percentage
Tutors	6	50.00%
Guest speakers	**11**	**91.67%**
Case studies	3	25.00%
Site visit	4	33.33%
Other	1	8.33%

Table 4: Disciplinary background of non academic contributors

Answer	Count	Percentage
Philosophy and ethics (A18)	1	8.33%
Language acquisition (A20)	1	8.33%
Management and administration (A33)	2	16.67%
Biology (A41)	1	8.33%
Computer use (A53)	1	8.33%
Software and applications development and analysis (A55)	1	8.33%
Inter-disciplinary programs and qualifications involving Information and Communication Technologies (ICTs) (A57)	1	8.33%
Hygiene and occupational health services not elsewhere classified (A99)	1	8.33%
Inter-disciplinary programs and qualifications involving services (A103)	1	8.33%
Other	2	16.67%

External courses attended by the respondents included conferences (92%), seminars and webinars (86%), summer schools (44%) and courses (36%). Of these, 72% were interdisciplinary in nature. A wide range of disciplines were included across these external offerings including:

- Education, technology, sociology
- Health, wellbeing, communication, popularisation of science
- Medicine, physics, data science
- information studies, computer science
- Healthcare, information systems, human-computer interaction, informatics, ICT

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- Chemical Engineering, Advanced materials, Bioinformatics
- Business, Science, Law, Sociology, Education
- engineering, management, marketing, statistics
- Sociology, anthropology, economics, entrepreneurship, human geography
- Anthropology, Sociology
- Engineering, Medicine
- Sociology, Education, Sports Science, Public Health
- Digital Forensics, Social Wellbeing etc
- Nutrition, statistics, computer science.
- all disciplines
- Medical/Veterinarian/Forestry/Computer sciences
- biology, law, economics
- geography, cartography, database management, monitoring technologies, civil planning and engineering, machine learning
- Geography, Computer Science, Bioinformatics
- Education
- Microbiology, Agriculture, Entrepreneurship
- Computer Science Journalism and Media
- Computer Science, Journalism and Media
- Psychology, Education and Sports Science
- Various academic disciplines; Agriculture; Education
- Biology, Informatics

Only 21% of the Student respondents felt that they had attended an inter-sectoral (which involves participation outside academia) course that had broadened their career prospects beyond Academia. 92% of these courses (50%), seminars (25%) and summer schools (25%) did not form part of their formal PhD programme.

Regarding the modules during the PhD studies, 84% have taken part in both internal, 71.43%, and external, 85.71%, courses. In 40% of the internal PhD courses there was involvement from non-academic tutors/speakers mostly (91.67%) as guest speakers, while the disciplines vary. The external activities students attended were mostly both seminars/webinars and conferences, while the 72.22% (26) were interdisciplinary in various disciplines.

From the 50 in total participants, only 9 (21.43%) attended an inter-sectoral course that was useful in terms of broadening their career prospects outside Academia, while from the rest, only 4 attended any other course that was useful in terms of broadening their career prospects outside Academia.

92.31% (12) of these courses were external courses, 62% (8) of which were organized by academia and 15% (2) by industry. Interestingly, 23% (3) of these courses were organized by professional bodies perhaps indicating a role for such bodies as a bridge between academia and industry careers. 46.15% were interdisciplinary in the following combinations:

- Health and wellness, ICT, medicine, computer science

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- Designer, Engineers
- Education, Sport Science, Psychology, Business
- Business, science, law, communication
- Sports Science, Education, Psychology and Nutrition
- Health, Informatics

The two most prevalent ways in which students were directed towards these courses were through advertisement (23%) or at the suggestion of their supervisor (23%). The duration and timing of the course were considered most important characteristics in deciding to take the course with a mean value of 4.38, followed by the structure (3.77) and teaching/learning strategy (3.67). Of the motivations driving the selection of a course the most important seemed to be the improvement of soft and academic skills with mean values of 3.92 and 3.73 respectively. Where students felt that such courses had improved their soft skills they cited areas such as managing challenges in the workplace such as negotiation and conflict resolution, mental health awareness and self-motivation; networking skills, group-work,ing skills and communication skills including presentation skills, communicating in English, and communicating to a lay audience. Students felt that these courses also directly impacted on their own PhD programme in terms of integration where they were new to that country, in particular integration into the healthcare domain. This type of course helped students to think about how I might communicate the ideas from their PhD studies to a broader audience with some offering technical skills to do so such as website creation or programming skills. Overall, students expressed a deeper understanding of their area of interest.

Student respondents suggested ways of improving these courses going forward. These included having more guest speakers, as well as better engagement between the speaker and the audience, more activities to understand the transition that takes place. Students also sought more practical content and a greater length of time spent on this practical aspect. Respondents also referenced courses that they would have liked to attend but did not have the chance to do so. These included time management and mental health for PhDs with an emphasis on learning 'how to say no'. Business related courses also featured as did communication and writing skills, in particular scientific writing and scientific presentation.

In regards with the modules' structure, 46.15% (6) are modules that are performed on demand and are not included in a specific timeline, while for 38.46% (5) the duration was '1 week or less but more than one day'. 76.92% (10) of the modules were free of charge and for the 92.31% (12) the structure of the module included lectures with projects and hands-on experience also featuring strongly,each at 46% (6). 69.23% (9) demanded physical presence in class and the 38.46% (5) of the modules were publicly available although the remainder required either an application process (31%) or were only open to the members of a particular programme (31%). Finally, 46.15% (6) of the modules had no evaluation and 61.54% (8) offered no ECTS.

Where students believed that the course(s) taken had had an impact on their careers they expressed this impact in multiple ways. Some found it useful to understand the

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trajectory another individual took as they could see themselves on a similar path. They gained an understanding of the effects of leaving academia and opportunities for improving work patterns. Students also found it interesting to hear about different career opportunities within Academia learning to distinguish between more research-oriented opportunities versus combination of research and teaching. Networking was also an important benefit with courses offering an opportunity to meet other researchers and create a network of colleagues. Students believed that the knowledge and exposure that they had gained in the area of intellectual property would be valued by employers both within and outside of academia. Specific technical skills were also seen as of value to further potential employers.

3.2.2 Program Directors

Regarding the second group of participants, program directors, 7 had participated in the coordination of internal PhD courses, while 6 had been involved in the development or delivery of external courses. In the latter external courses, there was involvement of non-academic speakers, mostly as guest speakers (2) and the same proportion (2) of the external courses were interdisciplinary in nature.
5 of the directors participating in the survey said that they would encourage their students to attend such activities. Reasons cited by respondents included the importance of gaining a broader lens with which to view the world, leading to creative and innovative thinking. Directors also believed that such courses open up new networks for students that offer new ways of thinking and expose them to contrary perspectives which may seed new research ideas or help them to better defend and explain ideas that they already have. Exposure to real world challenges meant, for the Directors, that their students might better see how their research will fit into the world outside the university. This was felt to be particularly important in light of the fact that the majority of PhD students will not work in an academic setting and need to gain experience of topics and aspects of working that are important in industry and other non-academic centers.

Despite this favorable perspective, only 3 had participated in the design of courses that broadened students' career prospects beyond academia. All of these courses, 3 in total, fell outside of the formal PhD programme and all were both intersectoral and interdisciplinary in nature despite a heavy involvement from academia. The disciplines included are:

- Medicine, Engineering
- Social sciences, ICT, engineering, medicine
- Medicine, Nursing, Physiotherapy, Education Technologist, Education Developer

These courses focused on developing specific skills, like collaborative writing and problem solving. The reasons that these courses are attractive to students, according to the directors, are the interdisciplinarity and the networking opportunities. 2 of these courses were included in the standard PhD program, lasted less than 3 months and there was no fee to attend. Directors suggest that these courses are more valuable when attended in the late years of the studies. All of them required a physical presence in class

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and were available to members of a certain faculty or subject to an application and acceptance procedure. 2 of the courses had evaluation, as projects and continuous assessment. Completion rates for the courses were very high

Respondents offered some examples of the types of courses that they had been involved in developing or delivering:

Table 5: Sample courses that respondent Directors were involved in

Title	description
Critical appraisal of the literature	Formulation of the research question Formulation of research question, formulation of search strategy, bibliographic databases Searching bibliography principles
Collaborative Writing	Forming writing groups of students from the multiple disciplines that contribute to connected health research and facilitating discussions to generate common research topics that may lead to an academic paper.
Interdisciplinary learning through problem-based learning in the Clinical Environment	The course presents interdisciplinary student groups with opportunities to discuss specific patient cases. Each of the individuals within the group brings their own disciplinary knowledge to the table.

They also offered their perspectives on those attributes of the courses that made them attractive to the students. Like the student respondents, the highest scoring of these was timing. Beyond that, however, interdisciplinarity (4.67) and networking (4.5) rated very highly indicating a positive attitude towards the spanning of the academic boundaries of discipline and institution. While intersectorality did feature as an attracting attribute it seemed less important, at least in the eyes of the program Directors, ranking a 3. It is notable that Directors feel that the assessment strategy has a relatively minor impact on the attraction of the course (2.5).

Structure was also considered important (4). When asked how the course was structured respondents indicated an equal distribution of lectures, offline materials without lectures, projects, and hands-on experience.

When asked to critique their own courses Program Directors had little to say in terms of how they might improve them with only two responses. One highlighted a need to spend more time explaining the learning goals of the module up front, while pacing the learning and collaboration activities over a longer period. A second respondent said that they would, in a future iteration, seek to broaden the range of disciplines involved in the course.

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3.3 Summary

In summary, the two surveys between them indicate that most PhD students do not attend courses or modules that aim to broaden their career opportunities outside academia and most directors do not organize such courses. For the ones that do, the courses are not embedded in the PhD program, but take the form of external activities such as webinars/seminars or summer schools.

Moreover, these courses are often organized by academic organizations in collaboration with industry and tend to be interdisciplinary. Such programs give the opportunity to the students to broaden their knowledge of basic education by merging different fields of science.

The main reasons for selecting a specific course, seem to be structural. The students prefer brief and comprehensive courses to enrich their skills in specific fields. On the contrary, directors believe that a longer period and the involvement of more disciplines would improve the courses. Finally, the students want more practical modules that allow the direct application of the obtained knowledge.

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4. Part III: Industry/Government Doctoral Education Policy Analysis

4.1 Method:

Three searches were conducted for non-academic reports and policy documents relating to doctoral education policy as follows:

1. Directorate General (DG) for Education, Youth, Sport and Culture strategy and plans.
2. EU level policy reports citing doctoral education.
3. Big 4 (KPMG. PwC, EY, Deloitte) consulting reports citing doctoral education.

The first of these searches was conducted within the Directorate General for Education, Youth, Sport and Culture website while the second and third searches were conducted using Google's advanced search function. Filters applied were as follows: pdf format documents, English language, and that the website had been updated in the last year. These filters ensured a level of formality, the author's ability to analyse the information, and the currency of the documentation respectively. Table 1 below lists the documents retrieved and analysed. Analysis took the form of a narrative review.

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Table 1: Policy and Industry Documents Related to Doctoral Education

Search	Documents Retrieved and Analysed
DG Education	1. European Commission, (2020), *Commission Work Programme 2021: A Union Of Vitality In A World Of Fragility*, Brussels, 19.10.2020 Com(2020) 690 Final Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions. 2. *Strategic Plan 2020-2024* Directorate General For Education, Youth, Sport, And Culture Ref Ares(2020)4764872 – 11/09/2020
EU level policy	3. European Parliament, *The future of tertiary education in Europe*, Authors: Denise Chircop, Cemal Karakas, Monika Kiss and Marcin Szczepanski, with Lea Schomaker Members' Research Service PE 652.095 – September 2020 4. *Tracking the careers of doctorate holders*, EUA-CDE Thematic Peer Group Report, October 2020 5. EUA (European Universities Association), *Perspectives on the new European Research Area from the university sector*, December 2020 6. Mark Whittle, James Rampton, *Towards a 2030 Vision on the Future of Universities in Europe* Policy Report, Independent Expert Report, Centre for Strategy & Evaluation Services LLP (CSES) September – 2020 7. Yerun *Annual Report 2020* 8. Eurodoc, *Policy Input for European Higher Education Area: Focus on Doctoral Training and Doctoral Candidates*, Brussels, Nov 2020
Consultant reports	9. KPMG (2019) *Future Proofing the University* 10. KPMG (2020) *The future of higher education in a disruptive world* 11. Deloitte Insights, *Superlearning*, 29June 2020 12. World Economic Forum (in collaboration with PwC) Upskilling for Shared Prosperity INSIGHT REPORT JANUARY 2021 13. EY (2018), Halloran & Friday, *Can the universities of today lead learning for tomorrow? The University of the Future*

4.2 Findings:

4.2.1 A Vision for a Better World

The European Commission work programme 2021 sets out a "vision of building a fairer, healthier, greener and more digital society"[1] (p.1). This will, however, "require Europeans to acquire new skills" through a "lifelong learning culture" and empowering

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"individuals to undertake training and manage their career." [1] (p.7). DG Education, Youth, Sport and Culture's mission is to "contribute to a knowledge-based Europe with the aim to achieve a competitive economy and an inclusive society, while addressing both the green transition and the digital transformation"[2] (p.4)

4.2.2 Context Change

According to EY we have entered the Transformative Age: "much like the Industrial Revolution before it, we can expect fundamental shifts in how we live, work and play. The Transformative Age will also change how we learn – and, along with it, the nature and role of the university." [13] (p.2)

Many of the reports and policies analysed emphasised the seismic change that we are currently living through in terms of education. This was already in existence according to many of the commentators but the Covid-19 pandemic has triggered an acceleration of such change: "Changes in climate, digital technologies and geopolitics were already profoundly affecting our society and driving our agenda. However, the pandemic has sharpened the need for Europe to lead the twin green and digital transitions and make its societies and economies more resilient. This creates an unparalleled opportunity to move out of the fragility of the crisis by creating a new vitality for our Union." [1] (pp1-2) The European Commission work programme 2021 makes reference to 'NextGenerationEU', a temporary instrument designed to boost post-COVID-19 recovery, though a €1.8 trillion stimulus package: "It will be a greener, more digital and more resilient Europe. Europe is not only choosing to repair the damage, recover for today and support those most hit by the crisis, but also to deliver and build a better way of living for the world of tomorrow." [1] (page 2). DG Education claims a critical role for education and science "in responding to global threats with common solutions…[requiring] multilateral cooperation, sharing evidence-based knowledge, experience based mutual learning, digital education, distance and blended learning, virtual mobility and on-line resources to maintain learning continuity."[2] (p.7).

According to Deloitte, the very nature of work has changed due to "technology innovation, a growing demand for new competencies, changing employee expectations, shifting labour demographics and inclusion/diversity strategies, new workforce models, and the evolving business environment with all its regulatory changes."[11] (p.1). The World Economic Forum therefore calls on education providers to embrace this future of work as a source of reinvention; " to normalize lifelong learning for all – Prioritize vocational and higher education curricula that are "just in time" rather than "just in case", working with business – Scale up the provision of self-directed learning and nano-degrees for lifelong learning – Build bridges between national qualification systems and lifelong learning so skills are recognized globally – Connect schools and places of learning with each other globally"[12] (p.9)

DG Education identifies two key transitions - digital and green – that will "progressively alter the set of competences needed, and the way culture is created, produced, promoted, consumed and monetised."[2] They identify a key role for educators in addressing these challenges and opportunities to deliver the knowledge, skills and sustainable education needed for "technology and the future of work, digitalisation of

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society and learning, or the transition to a circular economy."[2] (pp6-7). The EUA recognises that these two transitions, alongside Covid-19, "have resulted in greater and more urgent expectations towards universities and other R&I stakeholders to provide innovative and evidence based solutions." [5] (p.5). They warn, however, that "investigator-driven and mission-oriented research need to be valued and fostered on par with innovation" (p.5) and highlight that, despite Council Conclusions that stress the importance of "the full range from fundamental to applied research and innovation", "both the Conclusions and the Communication focus to a great extent on innovation, through the market deployment of technological developments and the important role of industry in research. More substantial attention needs to be paid, instead, to the unique and mutually reinforcing contributions of the full range of research activities and the diverse landscape of R&I stakeholders. Frontier research is critical to develop robust and resilient R&I systems and to pave the way for disruptive innovation."[5] (p.5)

Chircop et al (2020) advise the European Parliament of 6 key policy areas that impact on third level education: "(1) meeting environmental, societal and ICT challenges; (2) the impact of digital and disruptive technologies; (3) collaboration with business; (4) improving global collaboration and intra-EU mobility; (5) quality assurance; and (6) the financing of tertiary education, including fees and barriers to inclusion."[3] (p.2)

4.2.3 Key Goals:

In translating the European Commission's workplan into a strategy specific for DG Education, Youth, Sport and Culture, the DG cites its emphasis on green mobility, sustainability and innovation through key actions such as Erasmus, the European Solidarity Corps, the Marie Skłodowska-Curie Actions and Creative Europe. It highlights the ability of its European Institute of Innovation and Technology (EIT) and its Knowledge and Innovation Communities (KICs) to "play a key role in that regard by contributing to strengthening innovation ecosystems through the integration of the knowledge triangle activities (education, innovation and research)."[2] (p.3)

Spreading innovation is seen as key to the digital transition "by ensuring strong collaboration and smart specialisation between universities, research centres and firms, and adequate availability of skills."[2] (p.9) DG Education goes on to specify four key criteria for successful digital transition:

- New environments that are conducive to collaboration and innovation;
- Stronger innovation capabilities across both academia and the research sector;
- A new generation of entrepreneurial people; and
- The creation and the development of innovative ventures.

Key skills identified, partly as a result of the Covid-19 crisis, include "resilience skills… outreach and networking, not only for addressing the immediate health challenges, but also to anticipate the broader societal, ecological and economic implications of the outbreak and enhance Europe's preparedness in the future"[2] (p.12). Eurodoc (European Council of Doctoral Candidates and Junior Researchers) calls for quality standards that encourage transferable skills training in doctoral programmes.[8] Deloitte identify what they term 'Power skills: Fostering unlearning, learning, relearning: Power skills, defined

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by Massachusetts Institute of Technology professor Anant Agarwal as "hard-won and rigorously maintained abilities, such as critical thinking, persuasive writing, communications and teamwork" [11] (p.8)

Chircop et al. (2020) identify a need to recognise teaching quality in academic progression and teaching skills training at doctoral level: "doctoral candidates are not just early stage researchers but also early stage academics and as such need training and peer support to develop their teaching capabilities."[3] (p.5). This has many benefits "as doctoral candidates are at the forefront of research, they are in a good position to make teaching more research oriented. At the same time, teaching helps the candidate master a topic more quickly and broadly."[3] (P.5)

"The Commission … notes that the "training and career development of researchers insufficiently focuses on entrepreneurship or opportunities outside academia." It also identifies a "skills mismatch" and is interested, overall, in boosting the inter-sectoral mobility and entrepreneurship of early-career researchers, while calling for the "involvement of the private sector in training and skills development of researchers." The Council Conclusions also note the need to broaden researchers' skills and competences and propose an "enhanced European Competence Framework for Research Careers." Through its Council for Doctoral Education, the European Universities Association (EUA) has been the main protagonist in reforming doctoral education in Europe, notably through the 2005 "Salzburg Conclusions and Recommendations" and the 2010 "Salzburg II Recommendations". The latter note that European universities agree on the principle that the "core component of doctoral training is the advancement of knowledge through original research", while "doctoral training must increasingly meet the needs of an employment market that is wider than academia." EUA's Doc-Careers II and EUIMA projects describe how industry relies on researchers with a solid research training. This makes investigator driven research a key pre-condition for successful research careers also in the private sector. Therefore, EUA sees a clear connection between investigator-driven research and the support of inter-sectoral mobility and entrepreneurship. EUA stresses that universities are well able to equip researchers with the necessary basic and advanced skills to meet current technological and societal challenges. At the same time, universities also engage in and co-implement numerous collaborations with partners outside of academia. Through collaborative doctoral education schemes, universities foster the involvement of public and private sector actors in doctoral training."[5] (p.13)

The European Research Area (ERA) was proposed in 2000 in the European Commission Communication, "Towards a European Research Area" and in 2009 the idea of developing a common research area was incorporated into the Treaty of Lisbon. "The ERA's priorities are to improve and harmonise the conditions for R&I in Europe, and to foster a prosperous European research environment."[6] (p.13) "Researchers are at the centre of ERA and Art. 179 as they are the creators of knowledge and through mobility can bring their expertise to other institutions and other sectors." [6] (p.85)

Whittle and Rampton (2020) call on universities to "strengthen their training capacity to ensure that researchers are equipped to deliver highly creative, solutions-oriented,

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societally-relevant research, and at the same time improve the resilience of (post)graduates and doctoral researchers to work in the context of rapidly-changing societal needs. Improving universities' capacity to address the societal challenges could in turn improve societal resilience to adapt to change." [6] (p.78). They highlight, however, this is not widespread citing a survey carried out by the European Commission in the MORE3 study which "showed that while 81% of PhD candidates consider transferable skills training important, only 33% received such training." [6](p.89)

It is possible, however, that doctoral students are not being given due consideration when setting such goals. Eurodoc, the European Council of Doctoral Candidates and Junior Researchers, bemoans "only brief mentioning of doctoral candidates or their inclusion only within general expressions like "students", "staff", "higher education", "learning", or "research"" in the last three Ministerial Communiques (2015, 2018, 2020)[8]. In their view "such reductive terms limit the vision for developing doctoral training in EHEA. Student-centered learning, broadly discussed in recent communications and highly relevant for first and second cycle students, does not reflect the essence of the third cycle. Likewise, research-based training is absent in recent EHEA Ministerial Communiques and other Bologna Process documents."[8] (P.2) While quality assurance and doctoral education have been stable elements of the Bologna Process since the 2003 "the specific issues concerning the quality of doctoral training are not sufficiently discussed at the European level and dedicated recommendations for evaluation or accreditation of doctoral programmes would promote the recognition of the value of doctorate (e.g. recognising interdisciplinarity in research)"[8] (P.2)

4.2.4 The role of the university

There are "growing expectations that universities will not only undertake their core pedagogical function and carry out research, but also engage in other activities, such as contributing to the development of culture, cooperating outside academia, citizen engagement in research and science carried out by universities through societal outreach, and the use of research to tackle societal challenges."[6] (p.15). European universities "play a key role in developing human resources, thereby fostering a pipeline of talented researchers to carry out research in academic and non-academic contexts (e.g. industrial research, research benefiting the public sector, and challenge-driven research to address societal and global challenges). As such, universities and their researchers at all career stages have an important role to play in the education, research and innovation nexus (the "knowledge triangle")"[6] (p.15)

"They also play an important role in developing highly-skilled (post) graduates and researchers and enable them to access employment opportunities, thereby addressing skills shortages. They also provide pathways for researchers to develop their careers at PhD, post-doctoral levels, and tenured positions in academia; as well as to provide a talent pool for businesses seeking to recruit highly-skilled, highly-qualified staff either to carry out research in industry, or to deploy scientific rigour to problem-solving in business."[6] (p.17) Whittle and Rampton articulate the university's mission as being "to create and transmit knowledge, to contribute to the development of their capacity to create, transmit and facilitate the application of such knowledge."[6] (p. 85). This means, they claim, that academic, researcher and doctoral candidate skills become essential

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considerations. They contrast this with many policy makers' focus on research metrics that involve "quantifiable "things" including ideas, theories, discoveries and methods that are represented by publications, patents and education. This ignores the equally if not more important outcome of having highly trained researchers and students with the skills to analyse and solve complex problems."[6] (p.85) They suggest that developing this type of human capital requires a "robust career development plan with training that incorporates a variety of areas from leadership to commercialisation." [6](p.85) The 2030 generation of researchers need to be practitioners of Open Science and be equipped with the skills to work as academics but also to work in wider non-academic areas of employment. Moreover, the university recruitment and career progression process must change to embed the practice of open science and ensure greater intersectoral mobility." (p.85)

While DG Education articulates "four missions of universities: education, research, innovation and service to society"[2] (pp18-19), transformation and the acceleration of transformation in the higher education sector are key themes throughout the reports reviewed. The reasons for such calls for transformation include:

- Empowering EU citizens "with the high-level competences (knowledge, skills and attitudes) necessary for their personal, social, civic and professional development in a fast changing society."[2] (pp18-19). The 2020 World Economic Forum Annual Meeting 2020 launched the Reskilling Revolution platform, "an ambitious effort to bring together governments, business, online learning platforms and civil society organizations to provide better education, skills and jobs for 1 billion people by 2030...At the heart of the report is a realization that our economies are no longer delivering what people need and require systemic reform. And by giving all people opportunities to build the skills they will need to fully participate in the future workplace, we can start to create more inclusive and sustainable economies and societies where no one is left behind." [12] (p.3)
- Maintaining societal relevance: "Higher education institutions provide both teaching and research functions with a clear impact on economies and the future of generations of young people."[3] (p.I). "Communities need to see that higher education institutions in Europe are beneficial to them…driving closer collaboration and partnerships between research institutions and business, as well as a debate on how research outputs can be shared and used."[3] (p.14)
- Competition in knowledge-based economies: As Chircop et al. (2020) advise the European Parliament, this has led to academic excellence being "determined by rankings, with academic funding often being granted based on specific performance criteria."[3] (p.I)
- Wider outreach and greater inclusivity: "the notion of education as a public good can put a different set of pressures on the financing of tertiary institutions."[3] (p.I).
- Digital transformation "has far-reaching consequences for the future of universities. In fact, due to their pivotal role in society, higher education institutions are placed at the very centre of this profound transition, which brings with it both extraordinary opportunities and risks." (p.8). Educational

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systems "are encouraged to shift their focus on the very skills and competences that for the time being cannot be entirely automated: creativity, problem solving, negotiation, adaptability, critical thinking, working together, empathy, emotional intelligence and cross-cultural communication." [3] (p.11). KPMG identify new competitors in the form of more affordable online education, expecting e-learning to grow at a compound annual growth rate of 7.5 to 10.5 percent between 2018 and 2024: "Many traditional universities are organizationally unable, or culturally unwilling, to participate in this and some competitors are becoming stronger and stronger"[10] (p.6)

- To catalyse intersectoral cooperation by bridging "the cultural gaps that characterise current differences between sectors… translating this into strategic relationships over time. Universities need to ensure that they develop the necessary relationships with different sectors to enable their doctoral and post-doctoral researchers to work in different sectors, and crucially, ensuring that any period spent in another sector is recognised as part of career progression structures." [6] (p.117). EY highlight that while technology is driving convergence in almost every industry, "For universities, convergence heralds competitive threats from new entrants with disruptive business models. But it also offers the opportunity to collaborate on research and innovation, curriculum design and work placements. Will the ivory tower become the ivory network, as universities go beyond pure research[13] (p.8)
- Payer opinion is changing. KPMG claim that "Many employers say they are looking primarily for things that universities do not directly teach, such as social skills, emotional intelligence, teamwork, communication and time management." [10] (p. 6) At the same time: "Aging populations and the politics of healthcare are a powerful competitor for public funds, and votes. Cuts in public funding for universities have been experienced in many jurisdictions, partly offset by rises in student fees which have compounded the graduate debt problem." [10] (p.6)
- Demand for experiential learning that will challenge the traditional university model. KPMG point out that most degrees (excepting teaching and health courses) do not incorporate extensive periods in practice. They acknowledge that "Work-integrated learning is hard to scale up in the standard business and operating model of a university, but that is where the demand will be; from students themselves, and their prospective employers. A likely development in post-secondary systems is a greater integration of higher and vocational education, to create new blends of abstract and applied learning."[10] (p. 15). Deloitte capture this trend in their concept of "superlearning": "a feedback loop; content updates that are informed by real-world cases, feedback or experiences; and artificial intelligence algorithms that make it easier to find content, provide contextual relevance, and streamline editing to ensure content matches the target audience." [11] (p.4)

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Prescriptions as to how to achieve such transformation include co-operation between higher education institutions across the EU. Yerun, for example, formed a consortium of six of its members (Link EDU-RES) in November 2019 to focus on the internationalisation of doctoral education and the establishment of collaborative and interactive frameworks for its operation: "Specifically, aims at laying the ground for the creation of joint programmes at doctorate level within young European research universities." [7]
Levers for change available to the EU include:

MSCA: Between 2014 and 2020, over 1 000 doctoral programmes will have been funded, "strengthening Europe's human capital base in Research and Innovation, by supporting sustainable collaboration through doctoral programmes and staff exchanges, and by fostering structural impact on the European Research Area."[2] (pp11-12). MSCA is a "'bottom-up' and idea-driven programme… leading to significant and innovative contributions to major societal challenges and Commission priorities"[2] (p.12)

EIT: EIT's remit is to "boost sustainable European economic growth and competitiveness by reinforcing the innovation capacity of the Member States and the Union."[2] (p.12). To do so it builds EU-wide innovation ecosystems of education, research, and business aiming for a target of 3% of GDP for research and development across the Union by 2020. Outcomes include "the creation of cross-border, multidisciplinary networks, more cross-sectoral cooperation and geographical outreach."[2] (p.12). "The EIT also set up ICT labs to foster entrepreneurial ICT talent, which helps to orient higher education towards innovation and entrepreneurship. For the same purpose, it also set up knowledge and innovation communities, together with co-location centres and mobility programmes, to bring people from different countries, disciplines and organisations together."[3] (p.13)

4.2.5 Intersectorality & Interdisciplinarity

Future-proofing, according to KPMG, will mean "building mechanisms so that understanding of the world outside Universities is drawn in systematically and across the full range of academic disciplines." This will allow universities to "shape the work of businesses through their research and teaching innovations which capitalise on new technologies, processes and approaches." They caution that "the greatest value will be for those Universities that don't just respond to industry needs but work in partnership for long-term mutual benefit…it will be important for Universities to consider what they will not do as these ventures can be time and resource heavy; often will require new modes of provision or working and thus, often, directly impact on the academic 'core'." [9] (p12)

DG Education identifies the European Institute for Innovation and Technology as key to the achievement of the intersectorality required for the **European Green Deal.** The institute will "promote collaboration among the knowledge triangle on climate change, sustainable energy, food for the future, and smart, environmentally-friendly urban transport." [2] (p.8). The DG sees "well-trained, dynamic and creative researchers and innovators [as] essential elements for the best science and the most productive research-based innovation"[2]. In 2011, however, only 46% of Europe's research and innovation talent pool worked in the business sector, much lower than in Europe's main economic competitors. To address this, the DG suggests that the necessary reform must

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start at the first stages of the researchers' careers, during their doctoral studies or comparable post-graduate training. Europe must develop state-of-the-art, innovative training schemes, consistent with the highly competitive and increasingly inter-disciplinary requirements of research and innovation. Significant involvement of businesses, including SMEs and other socio-economic actors, will be needed to equip researchers with the cross-cutting innovation and entrepreneurial skills demanded by the jobs of tomorrow and encourage them to consider their careers in industry or in the most innovative companies." (p.11)

Chircop et al (2020), advise the European Parliament that industry wants graduates whose skill sets align to their requirements and that this is why companies fund focused research in universities. They caution, however, that the European students' union, while recognising the importance of industry links, had concerns "that industry must cooperate with higher education institutions, respecting the value of freedom in teaching and research." [3](p.14)

Chircop et al (2020) paint a picture of an ideal industry-academia interaction where "both the expectations of industry and those of academia are satisfied to a similar extent and an equal partnership develops." Such productive collaborations are "strategic and long-term. They are built around a shared research vision and may continue for a decade or beyond, establishing deep professional ties, trust and shared benefits, which can bridge the important cultural difference between academia and industry. Ideally, they are led by individuals who understand both the academic and business world."[3] (p.14). This vision is widely shared, borne out in the fact that "Some 97 % of Europeans think that it is useful for students to work on innovative projects with researchers and companies from different countries. EU graduates who underwent some work-based experiences during their studies also reported better prospects in a graduate tracking survey conducted by the European Commission."[3] (p.16)

Whittle and Rampton (2020) identify a need to increase the inter-sectoral mobility of academics and researchers: "Whilst there remains a need for many academics to work in-depth within their own disciplines, two trends are increasing the need for inter-sectoral and inter-disciplinary mobility amongst researchers: first, the trend towards short-term funding for research positions at R2 and R3 levels in general; this is requiring researchers to change roles within academia or even into and out of other sectors; second, many of the key challenges facing society require solutions that draw on and combine expertise from different academic disciplines and with expertise from non-academic sectors. There is therefore a need to develop a mix of specialist and transversal competences, which typically requires a degree of inter-sectoral and inter-disciplinary mobility, although such mobility will take very different forms and vary across different disciplines." (p.88-89)

Whittle & Rampton's research identified "One of the university networks and also a business representative association [who] were strongly in favour of greater intersectoral mobility, not only of researchers, but equally, of academics, both from a knowledge transfer and a skills development perspective. However, it was recognised that this would demand a cultural shift. A university network that contributed to this

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study commented that "PhD holders' careers outside of academia continue to be seen as 'second-rate' compared to those who continue to work in the university and this is, in big part, due to the lack of equivalence between the two and, hence, to the fact that the profession of "researcher" is not officially recognised. Conscious that this cultural shift might take longer time to take place, we strongly believe in the need to expose academics as much as possible to the non-academic sector, and to continue to upskill and reskill"." [6] (p.89)

Whittle & Rampton identify remaining obstacles to intersectoral researcher mobility including "the inflexibility of national career systems for researchers and academics to secure recognition for periods of mobility to other sectors." [6] (p.111). They cite Klofsten et al. (2012), who found that doctoral engineering students were far more likely to undertake placements in the private sector that doctoral students from other faculties. The same study found that health sciences, arts and SSH candidates were more likely to undertake placements in other universities or within public sector organisations. Whittle & Rampton conclude that "This represents a missed opportunity as the public sector and third sector could benefit from applying the rigour of scientific methods to practical problems, such as how to improve and strengthen the efficiency of public service delivery." [6] (p.111)

Whittle and Rampton, looking ahead to 2030 and beyond, warn that universities may need to consider "the increasingly complex interactions between the various disciplines and sectors… [and] redefine the knowledge triangle and instead incorporate more dimensions, creating a "knowledge diamond" with increased interactions, synergies and interconnectivity between research, education, industry, government and society."[6] (p.23). They emphasise that this will require interdisciplinary collaboration "beyond traditional disciplinary structures."[6] (p.23). DG Education identifies EU programmes such as Erasmus+, European Solidarity Corps, Marie Skłodowska-Curie Actions, Creative Europe as key to fostering "interdisciplinary cooperation to develop best institutional practices and policy recommendations."[2] (p.8)

4.2.6 Doctoral Careers

KPMG highlight the need for universities to understand where students will go, requiring "a detailed understanding of local, national and international labour markets. What are the skills graduates need now? And how can Universities make sure that their graduates are adaptable for the future? An increasing focus on graduates' outcomes, and on the impact of research beyond academia make active engagement with the upstream value chain a non-negotiable part of a University's operation."[9] (p.12)

According to Eurodoc, one of the most significant issues facing early career researchers is the need for career development (especially for non-academic careers).[7] Eurodoc suggests that doctoral schools "should publicise and promote different career paths based on past and contemporary evidence, provide career management services appropriate for early career researchers, and ensure them sufficient mental health support."[8] (p.3)

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"The doctorate is essentially an academic qualification awarded for scientific work that entails the "advancement of knowledge through original research", as it is formulated in the so called Salzburg Principles from 2005."[4] (p.4). Whittle and Rampton (2020) in their independent report on PhD training maintain that it must be considered and potentially adapted "to equip PhD candidates and post-doctoral researchers and academics with better understanding and insights into the impacts of digitalisation in universities and in responding to likely future changes in skills and labour market needs and the related remuneration of researchers." [6] (p.22).

The European University Association report "Doctoral education in Europe today: approaches and institutional structures," released in 2019, showed that universities' commitment to doctoral career tracking "was often in the initial phase, with only 43% of the responding institutions having implemented career-tracking methods in most of their doctoral programmes."[4] (p.3). Enough evidence does exist, however, to say that "career paths outside of academia have gained additional importance and are increasingly not perceived as alternatives, rather - in many countries - as the most probable career path of a doctorate holder.[4] (p.4)

Whittle and Rampton (2020) identify a need to improve the employability of researchers. They point out that the global stock of researchers increased by 21% to a total of 7.8 million between 2007 and 2015.[6] This means that "the majority of EU doctoral candidates will not take up an academic career and thus they need to be better prepared for a wide range of careers in non-academic sectors. Researchers are not overqualified, but their contribution to sectors outside academia could be enhanced substantially if their academic training viewed this career option as plan A, not plan B. … This underlines the need for protected time for all researchers to access skills training and professional development."[6] (pp 87-88). The type of skills required, according to Whittle and Rampton, include "digital skills, leadership, commercialisation, open and responsible science skills (including Open Access publication, FAIR and open data management, research integrity and ethics, engagement with society, and the role of Citizen Science in strengthening engagement in Open Science). There is also a need to expose researchers to the non-academic sector, as a way of widening, enhancing and updating skills and experience." [6](p.88)

4.3 Conclusion

This analysis of policy and industry reports that deal with doctoral education highlights the changing context in which doctoral education now sits. Technology and sustainability drivers combine with employer demands and funding challenges to shape the employment context into which doctoral students must emerge at the end of their training. While perspectives differ on the best way to equip doctoral graduates for this new world, it is clear across all reports that excellent researchers and teachers are required in order for society to deal with many of its grand challenges. Doctoral education must, therefore, reach across boundaries to develop holistic and innovative research projects and researchers. At the same time, the core of what a PhD is, an academic qualification that recognises a novel scientific contribution, must be protected.

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5. Needs Identified

Across the systematic review; policy and industry review; and the two surveys a number of needs have come to the fore. These include needs at the societal, individual (i.e. student) level, the programme or module level, and the organizational (i.e. university) levels.

The policy and industry review identifies a changing societal context in which PhD education is embedded. This new context is creating additional skills and training needs that will quip doctoral graduates to make a real impact on key societal challenges. Digital and green revolutions are very much to the fore and the need to integrate all elements of the knowledge triangle into the design of doctoral education is clearly and widely articulated.

The systematic review identifies two clear needs at the student level including the development of transferrable skills; and the creation of formal and informal networking opportunities. Our surveys show, however, that most PhD students do not attend courses or modules that aim to broaden their career opportunities outside academia and most directors do not organize such courses. There is clearly a need therefore, for modules and courses that focus specifically in on the development of such transferrable skills and networking opportunities. A conundrum arises, however, as the student survey indicates a preference for brief and comprehensive courses to enrich their skills in specific fields – potentially conflicting with the idea of transferrable skills training. This seeming conflict may be resolved in the finding from the survey that students want more practical modules that allow the direct application of the obtained knowledge. This could perhaps be interpreted to understand that students want to see any transferrable skills actually implemented within a real-world environment that maps onto their field.

At the programme/module level the literature articulates the potential value of thoughtful and integrated supervision and mentoring. Our surveys indicate, however, that currently, access to the skills and networking needs articulated at the student level is not embedded in the PhD program, but rather requires them to step outside their formal structure to access external activities such as webinars/seminars or summer schools.

The literature review highlighted the need for change at the level of academic and organizational cultures if intersectorality and interdisciplinarity are to be encouraged within doctoral education. Organizations need to make room for supportive research cultures at departmental and university levels; while much work is also required in order to nurture of strong, boundary spanning professional and personal identities. This perhaps explains why the career-broadening modules mentioned within our surveys were often organized by academic organizations in collaboration with industry and tend to be interdisciplinary. Such programs give the opportunity to the students to broaden their knowledge of basic education by merging different fields of science and different sectors beyond the academic. This expanded and challenged the prevailing culture and allowed students to build boundary spanning identities for themselves.

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* Please note: documents reviewed in the policy and industry review are listed separately on page 26 of this report.

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Appendix I: Systematic Review, Publication Outlets Detail

Publication outlets: Education		Total
1.	Change	1
2.	Higher Education	1
3.	International Journal of STEM Education	1
4.	Academic Pathology	1
5.	International Journal of Education & the Arts	1
6.	Journal of Applied Research in Higher Education	1
7.	Higher Education, Skills and Work-Based Learning	1
8.	Environmental Education Research	1
9.	Journal of Chemical Education	1
10.	Biochemistry and Molecular Education	1
11.	Drugs Education, Prevention and Policy	1
12.	International Journal of Higher Education	1
13.	On The Horizon	1
14.	Industry and Higher Education	1
15.	Journal of Education and Work	1
16.	European Journal of Higher Education	2
17.	Innovations in Education and Teaching International	2
18.	Journal of Higher Education	1
19.	Journal of Teaching in Social Work	1
20.	Higher Education Research and Development	1
21.	Learning and Teaching	1
22.	Journal of Social Work Education	2
23.	Cultural Studies of Science Education	1
24.	Studies in Higher Education	3
25.	Frontiers in Education	1
26.	Studies in Graduate and Postdoctoral Education	1
27.	Perspectives: Policy and Practice in Higher Education	1
28.	Social Work Education	1
29.	Texas Music Education Research	1
30.	Asia Pacific Education Review	1
31.	Educational Perspectives	1
		36 (57%)

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Publication outlets: Healthcare		Total
1.	Journal of Professional Nursing	2
2.	Occupational Therapy in Health Care	1
3.	Nursing Outlook	1
4.	Nursing Research	1
5.	Research Quarterly for Exercise and Sport	1 1
6.	Physical Therapy	1
7.	BMC Health Services Research	1
		9 (14.3%)

Publication outlets: STEM		Total
1.	International Journal of Nanomedicine	1
2.	Bioscience	1
3.	Journal of Medical Internet Research	1
4.	Science and Public Policy	1
5.	Public Health Reports	1
6.	Climate Research	1
7.	GeoJournal	1
8.	Cyber Physical Systems	1
9.	Science and Engineering Ethics	1
		9 (14.3%)

Publication outlets: Management		Total
1.	Research Policy	1
2.	Innovar	1
3.	Simulation and Gaming	1
4.	Technology Innovation Management Review	1
5.	She Ji: The Journal of Design Economics and Innovation	1
6.	Techovation	1
		6 (9.5%)

Publication outlets: Other		Total
1.	European Planning Studies	1
2.	PLos One	1
3.	Research Integrity and Peer Review	1 1
4.	BMC Proceedings	
		4 (6.35%)

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Appendix II: Survey Consent Form

1. Informed Consent to Participate in Research

All participants should consent to the following statement to proceed to the survey:

"This survey is part of the CHAMELEONS project, funded by HORIZON 2020. The objective of CHAMELEONS is to develop new and innovative educational interventions to improve the learning experience offered by higher education to develop the skills and attributes of Ph.D./Postdoctoral students with the intention of shaping more adaptable, entrepreneurial and employable graduates, ready to meet the challenges of the future.

We would like to invite you to take part in a survey which will inform the CHAMELEONS project.

Before deciding to partake in this survey, please read and consider the following information.

The objective of this study is to survey course directors, PhD students, and post-doc researchers, in relation to courses which have been designed and/or which they have been undertaken during their doctoral studies and which they believe will or have impacted the graduates/their future careers. This is being undertaken in order to inform the development of innovative educational interventions.

This survey is being undertaken to identify intersectorally designed and/or delivered courses/modules which are available to PhD/Postdoctoral students.

It will take approximately 10 minutes to complete the survey.

In relation to Course Directors: This survey seeks to gather information about courses which are offered in your university which are designed from an intersectoral viewpoint with the intention of improving the skills and attributes of PhD and Postdoctoral students.

In relation to PhD students: This survey seeks to gather information about your level of education, the courses you have taken and the nature, structure, benefits, and requirements of these courses, and the impact you perceive they have had/will have on your career.

Please reply to all the questions. The answers are strictly confidential and pseudonymized and all personal information provided, will fall under EU General Data Protection Regulations.

Responses will only be accessible to researchers. All information will be stored in AUTH University's secure database. All partners within the CHAMELEONS consortium are bound by the legal undertakings laid out in the data sharing agreement.

This survey is completely voluntary and can be abandoned at any time during the process. You will be asked to consent to your anonymized responses being retained for

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research purposes. All answers will be encoded, all information will remain confidential, and no information can be shared without your consent.

All information selected will remain confidential and can only be shared with others with your written consent. Answers will be encoded with access given to the research team only. Survey results may be announced in conferences or published in scientific journals, without revealing any personal data or information.

No processed Personal data will be transferred to third countries (countries outside the EU, European Economic Area, Norway, Iceland, and Lichtenstein). Data collected will be kept for 5 years. Survey results will be published on the CHAMELEONS website.

Personal data cannot be used for any project other than CHAMELEONS without the participants consent.

To the best of our knowledge, there are no risks to physical and/or psychological integrity. In the unlikely event that participation in this survey causes any problem, the appropriate support will be provided.

If you have any questions about the research, complaints, or problems please contact Alexandra Kosvyra, aekosvyra@auth.gr

You can also address data.protection@auth.gr for any further clarification with reference to data protection and according to your personal rights. In any case, you have the right to resort to the Data Protection Authority for violation issues in personal data processing.

AUTH's Principal Investigator is Assistant Professor Ioanna Chouvarda, (+302310999247, ioannach@auth.gr).

Please check the following boxes to continue:

- I have read the participation information in the CHAMELEONS project and I declare that they were comprehensible.
- I agree to participate in the survey."

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Appendix III: Detailed survey results, Young Researchers

2. What is your status?

Answer	Count	Percentage
Young researcher	50	86.20%
Program Director	8	13.80%

3.4.2 Young Researchers

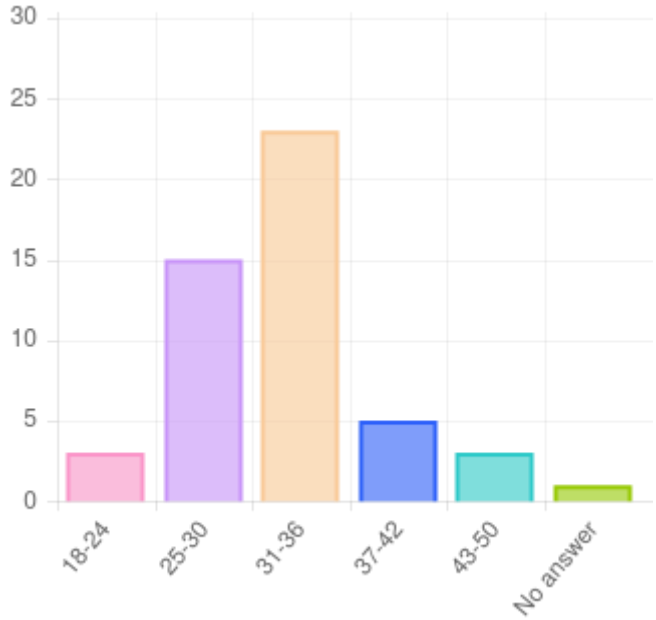
Section 1: General Questions
The following questions aim to obtain general information about you as the discipline of your Ph.D., the reason for starting a Ph.D. in the first place, what were/are your career plans, the stage of your Ph.D. studies (ongoing/completed) and the type of courses attended (Ph.D. program/other learning experiences).

3. What is your gender?

Answer	Count	Percentage
Male	20	40.00%
Female	30	60.00%

4. What is your age?

Answer	Count	Percentage
18-24	3	6.00%
25-30	15	30.00%
31-36	**23**	46.00%
37-42	5	10.00%
43-50	3	6.00%
No answer	1	2.00%



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5. What is the discipline of your basic education?

Answer	Count	Percentage
Agriculture	1	2.00%
Biological and related sciences	4	8.00%
Business and administration	4	8.00%
Education	5	10.00%
Engineering and engineering trades	**13**	**26.00%**
Environment	3	6.00%
Health	**7**	**14.00%**
Information and Communication Technologies (ICTs)	**8**	16.00%
Mathematics and statistics	1	2.00%
Physical sciences	1	2.00%
Social and behavioral sciences	1	2.00%
No answer	2	4.00%

6. What is the area of your Ph.D. studies?

Answer	Count	Percentage
Education science	4	8.00%
Audio-visual techniques and media production	1	2.00%
Management and administration	4	8.00%
Marketing and advertising	1	2.00%
Biology	2	4.00%
Natural environments and wildlife	3	6.00%
Earth sciences	1	2.00%
Computers use	1	2.00%
Software and applications development and analysis	1	2.00%
Information and Communication	3	6.00%
Inter-disciplinary programmes and qualifications involving Information and Communication Technologies (ICTs)	5	10.00%
Chemical engineering and processes	2	4.00%
Environmental protection technology	1	2.10%
Electricity and energy	4	8.00%
Electronics and automation	1	2.00%
Medicine	3	6.00%
Medical diagnostic and treatment technology	2	4.00%
Therapy and rehabilitation	2	4.00%
Inter-disciplinary programs and qualifications involving health and welfare	1	2.00%
Sports	1	2.00%
Other	7	14.00%
Responses:	• knowledge graphs • Machine Learning • Human Nutrition • Biology/Botan/Phytogeography	

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	• Atmospheric processes • Physiotherapy • Bioinformatics

7. When did you start your PhD?

Answer	Count	Percentage
2012	2	4.00%
2013	1	2.00%
2014	**3**	6.00%
2015	4	8.00%
2016	5	10.00%
2017	5	10.00%
2018	11	22.00%
2019	4	8.00%
2020	10	20.00%
No answer	5	10.00%

8. Why did you decide to start a Ph.D.?

Answer	Count	Percentage
Improve my academic skills	28	56.00%
I like research	**40**	80.00%
Social status	7	14.00%
Networking	4	8.00%
Career Enhancement	24	48.00%
Other	5	10.00%
Other Responses:	• I was interested in the topic and wanted to learn more about it. • I needed a job and a combination of my personality (curios and like to learn new things) and the way the ITN PhD program was described in the job offer. • Available opportunity • return to work. • employment	

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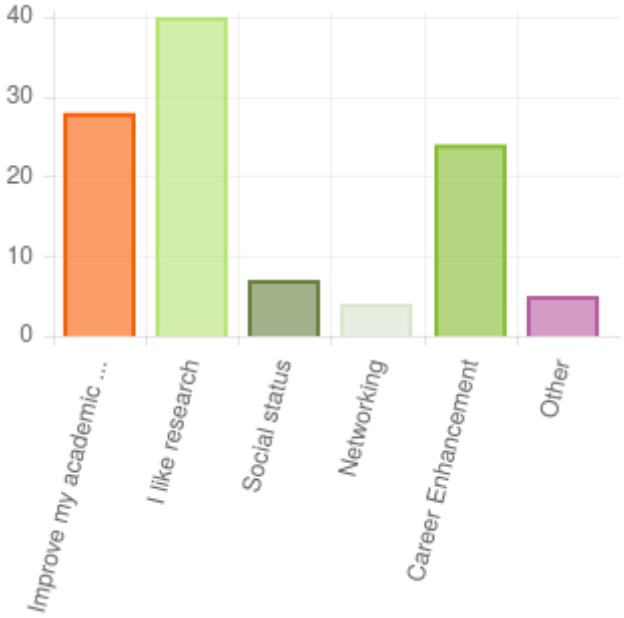
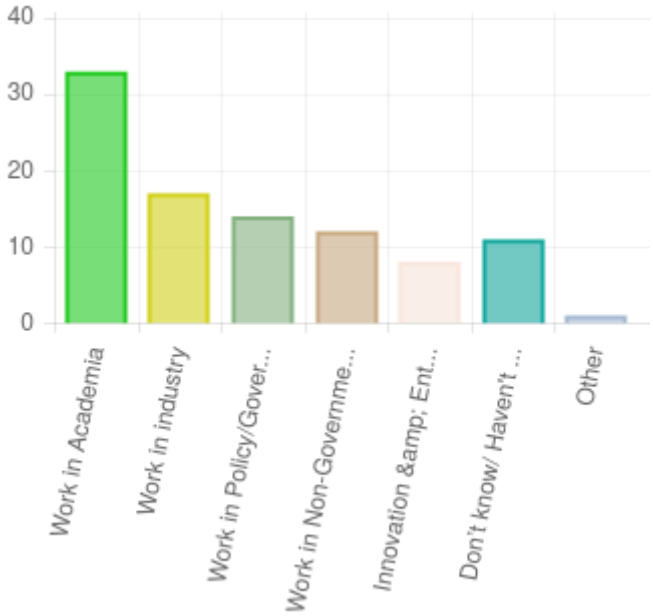


9. What are your career plans?

Answer	Count	Percentage
Work in Academia	**33**	**66.00%**
Work in industry	17	34.00%
Work in Policy/Government	14	28.00%
Work in Non-Government Organizations	12	24.00%
Innovation & Entrepreneurship	8	16.00%
Don't know/ Haven't decided yet.	11	22.00%
Other	1	2.63%
Other Responses:	ecotourism	



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10. Have you participated in any courses/learning activities while completing your PhD?

Answer	Count	Percentage
Yes	**42**	84.00%
No	5	10.00%
No answer	3	6.00%

11. What type of courses/activities did you participate in during your Ph.D.?

Answer	Count	Percentage
Internal courses, integrated in the Ph.D. program.	30	71.43%
External learning activities (seminars/conferences/summer schools etc.)	36	85.71%

Section 2: Internal Ph.D. Courses

This block of questions aims to obtain general information about the internal courses in the PhD program of the participant. These questions will only appear if the participant checks the corresponding box in question 9.

12. Was there any involvement from non-academic tutors/speakers in the courses of the Ph.D. program?

Answer	Count	Percentage
Yes	12	40.00%
No	18	60.00 %

13. In what capacity?

Answer	Count	Percentage
Tutors	6	50.00%
Guest speakers	**11**	**91.67%**
Case studies	3	25.00%
Site visit	4	33.33%
Other	1	8.33%
Other Responses:	Guest speakers and site visits from the university, all the categories from the ITN	

14. In what disciplines?

Answer	Count	Percentage
Philosophy and ethics (A18)	1	8.33%
Language acquisition (A20)	1	8.33%
Management and administration (A33)	2	16.67%
Biology (A41)	1	8.33%
Computer use (A53)	1	8.33%

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Software and applications development and analysis (A55)	1	8.33%
Inter-disciplinary programs and qualifications involving Information and Communication Technologies (ICTs) (A57)	1	8.33%
Hygiene and occupational health services not elsewhere classified (A99)	1	8.33%
Inter-disciplinary programs and qualifications involving services (A103)	1	8.33%
Other	2	16.67%
Other Responses:	• I am not sure about everyone's background • Intellectual Property	

Section 3: External Learning Activities

This block of questions aims to obtain general information about the external learning activities you attended during your Ph.D. studies.

15. What type of learning activities did you attend outside of the Ph.D. program?

Answer	Count	Percentage
Seminars/webinars	31	86.11%
Conferences	33	91.67%
Summer schools	16	44.44%
Course	13	36.11%

16. Where any of these activities interdisciplinary?

Answer	Count	Percentage
Yes	**26**	72.22%
No	8	22.22%
No answer	2	5.56%

17. What disciplines were included?

Answer	25	96.15%
No answer	1	3.85%

Responses:

- Education, technology, sociology
- Health, wellbeing, communication, popularisation of science
- Medicine, physics, data science
- information studies, computer science
- Healthcare, information systems, human-computer interaction, informatics, ICT
- Chemical Engineering, Advanced materials, Bioinformatics
- Business, Science, Law, Sociology, Education

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- engineering, management, marketing, statistics
- Sociology, anthropology, economics, entrepreneurship, human geography
- Anthropology, Sociology
- Engineering, Medicine
- Sociology, Education, Sports Science, Public Health
- Digital Forensics, Social Wellbeing etc
- Nutrition, statistics, computer science.
- all disciplines
- Medical/Veterinarian/Forestry/Computer sciences
- biology, law, economics
- geography, cartography, database management, monitoring technologies, civil planning and engineering, machine learning
- Geography, Computer Science, Bioinformatics
- Education
- Microbiology, Agriculture, Entrepreneurship
- Computer Science Journalism and Media
- Computer Science, Journalism and Media
- Psychology, Education and Sports Science
- Various academic disciplines; Agriculture; Education
- Biology, Informatics

Section 4: Specific Course

From now on you will answer the following questions for a specific course that you find useful in terms of broadening your career prospects outside Academia.

18. Have you attended an inter-sectoral (which involves participation outside academia) course that was useful in terms of broadening your career prospects outside Academia?

Answer	Count	Percentage
Yes (Y)	9	21.43%
No (N)	33	78.57%

19. Have you attended any other course that was useful in terms of broadening your career prospects outside Academia?

Answer	Count	Percentage
Yes (Y)	4	12.12%
No (N)	29	87.88%

Section 5: Course-specific General Questions

20. What was the title of the course that you found more useful for broadening your career prospects outside Academia? &
21. Describe the content of this course. &
22. Provide the web link of the course if available.

Title	description	Link

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I can't remember specifically but it was something like "Opportunities for PhDs in Industry"	Discuss how to transition between academia and industry, differences and similarities, types of organizations that exist in between such as individual research organizations that are not Universities, guest speakers presented information about why they left academia and the pressures they felt.	
Any languages	NA	
It was a one-day seminar called Developing and Managing an Academic Career, organised by the Irish Academy of Management in UL	The workshop aim was to provide IAM members with a range of professional and career development activities across the key strands of academic posts (Teaching, Research & Service). The focus was on career paths and development and involved panel discussions around the variety of career paths available to early career scholars; along with teasing out the benefits, drawbacks, opportunities and challenges of the different options. It also offered guidance on how best to develop and manage an academic career and academic/research network.	https://www.eventbrite.ie/e/iam-early-career-workshop-developing-and-managing-an-academic-career-tickets-89571900967
Design thinking	**NA**	https://www.innovators.ie/phd-modules/ https://open.hpi.de/courses/ideas2018
Inclusive Physical Education	The contents of the course covered a range of opportunities in order to create an inclusive environment for children with special educational needs and disabilities during the physical education classes. Alongside expert academics there also were a few non-academic professionals who outlined the job opportunities outside Education (school or third level education), namely in non-governmental organizations.	https://www.sg.tum.de/sportdidaktik/inclusive-teaching-team-elda/inphysed/
Exploring Intellectual Property	The course explored various aspects of intellectual property and highlighted various documents and policies that may be of use. The course very much revolved around	https://sisweb.ucd.ie/usis/!W_HU_MENU.P_PUBLISH?p_tag=MODULE&MODULE=IA40280

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	learning by doing with lots of individual and team tasks to complete. Attendees also had the opportunities to engage with guests who were involved in creating or protecting intellectual property.	
Running Injuries	Epidemiology of running injuries Mechanism of Injuries Management of Running Related Injuries	
Career development for scientists		
Python and Django Full Stack Web Developer Bootcamp	It is a tutorial for learning the Django full-stack web development framework	https://www.udemy.com/course/python-and-django-full-stack-web-developer-bootcamp/
Python for Environmental Science	Introduction to Python programming language for environmental data analysis and visualization.	
Programming for non-programmers	programming language python	
Inclusive Physical Education.	The contents regarded how to create an inclusive environment for students with with disabilities and special educational needs during physical education classes.	https://www.sg.tum.de/sportdidaktik/inclusive-teaching-team-elda/inphysed/datescondtitions/
Data Analysis in Systems Medicine	Realistic hands-on network data analysis in multiscale medicine / Network analysis on real data.	http://openmultimed.net/openmultimed-training-school-ljubljana-slovenia-september-23rd-27th-2019/

23. Was it external (outside the Ph.D. program) or internal (as part of the Ph.D. program)?

Answer	Count	Percentage
Internal	3	23.08%
External	12	92.31%

24. Please define, what type of external activity?

Answer	Count	Percentage
Seminars/webinars	3	25.00%
Conferences	0	0.00%
Summer schools	3	25.00%

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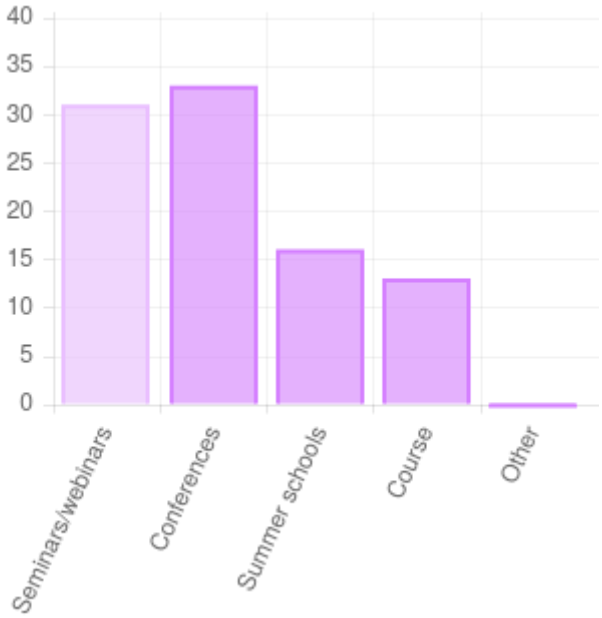
Course, outside my Ph.D. program	6	50.00%
Other	1	8.33%
Other responses:	Workshop	



25. Who organized the course?

Answer	Count	Percentage
Academia	8	61.54%
Industry	2	15.38%
Professional Organizations	3	23.08%
Other	2	15.38%
Other responses:	Myself Udemy Webinars	

26. Was the course interdisciplinary?

Answer	Count	Percentage
Yes	6	46.15%
No	5	38.46%
No answer	2	15.38%

27. Yes: What disciplines were included?
    a. Health and wellness, ICT, medicine, computer science
    b. Designer, Engineers
    c. Education, Sport Science, Psychology, Business
    d. Business, science, law, communication
    e. Sports Science, Education, Psychology and Nutrition
    f. medicine, informatics

28. No: What was the main discipline of the course?
    a. Languages

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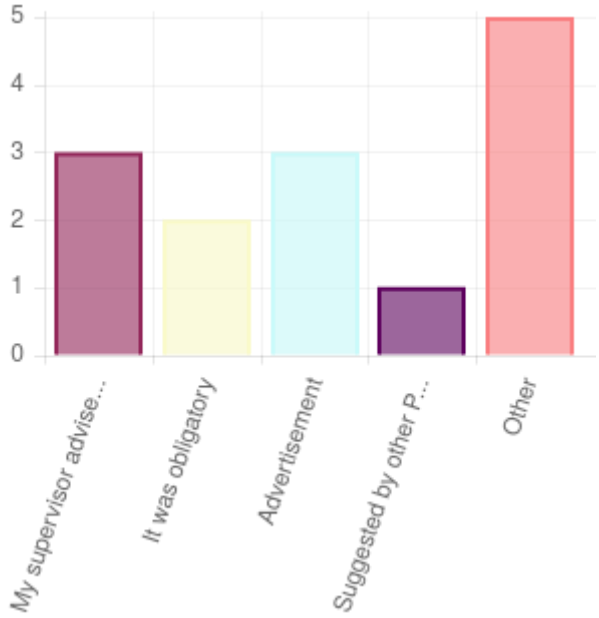
b. Business / Management
c. Physiotherapy
d. Programming / Web Development

Section 6: Course-specific Satisfaction Questions

The following questions aim to obtain information about the aim, evaluation, selection, satisfaction, the usability of the specific course.

29. How did you find this specific course?

Answer	Count	Percentage
My supervisor advised me to attend.	3	23.08%
It was obligatory.	2	15.38%
Advertisement	3	23.08%
Suggested by other PhD students.	1	7.69%
Other	5	38.46%
Other Responses:	• I was thinking about my future and the course was advertised in the University. • Was needed to integrate into the culture. • email from the Irish Academy of Management • I found it myself. • I searched for a webinar on this topic.	



30. Please rate the following attributes of the course in terms of their importance to you in deciding to take the course, where 5 is very important and 1 is not at all important.

	1	2	3	4	5	No answer	Arithmetic mean

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Duration and time of the course			**2**	**4**	**7**		**4.38**
The structure		1	4	5	3		3.77
Networking opportunities	2	2	2	3	4		3.38
Travel opportunities	3	2	2	2	4		3.15
Interdisciplinarity	2	3	2	3	2	1	3
Intersectorality	2	4	4	1	1	1	2.58
The teaching/learning strategy		3	1	5	3	1	3.67
The assessment strategy		2	5	4	1	1	3.33
Other reasons			2	1	1	9	

31. At what level did the following reasons contribute to your selection of this course?

	1	2	3	4	5	No answer	Arithmetic mean
Improve my academic skills.		2	3	2	4	2	3.73
Improve my soft skills.	1	1		6	4	1	3.92
Travel opportunities offered.	4	1	1	1	4	2	3
Networking opportunities	3	1	1	2	5	1	3.42
Other reasons		1	2		1	9	

32. Please define the additional reasons for selecting this course

Answer	Count	Percentage
	2	66.67%
The content of the course was relevant to my PhD.		
It is very useful both for prototyping and presenting my research results, but also as a career opportunity outside Academia.		
No answer	1	33.33%

33. What is the level of agreement with the following statements on a scale of 1 to 5 where 5 is very much and 1 is not at all?

	1	2	3	4	5	No answer	Arithmetic mean

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a. With this course did you get a Deeper understanding of a field related to your studies?	1	2	4	3	2	1	3.25
b. With this course did you obtain knowledge in a new field?	2	1	2	3	4	1	3.5
c. With this course did you obtain soft skills?	3		2	6	2		3.31
d. Were you in general satisfied by this course?			1	6	6		4.38
e. Did the course help you with your Ph.D. studies?	3	2	2	3	2	1	2.92
f. Do you consider the course a positive addition to your career pursued?	1	1	2	6	1	2	3.45
g. Do you consider the course a positive experience overall?			1	4	6	2	4.45

34. You answered positively in question c above, please define, what kind of soft skills (e.g., intellectual property, presentation skills, etc.)?

Answer	Count	Percentage
Answer	6	60.00%
No answer	4	40.00%

Responses:	Managing challenges in the workplace (communication & negotiation and conflict resolution), mental health awareness (self-motivation)
	I enhanced my group-work, presentation and networking skills.
	Knowledge of the nuances of intellectual property and where to go for further advice if required. Knowledge about communicating complex ideas to a lay audience.
	Presentation skills
	I improved my presentation skills in English. Furthermore, I improved my communication skills.
	The final assessment was a group presentation. Therefore, I had the opportunity to improve my presentation skills and those related to the group work.

35. You answered positively in question e above, how do you believe the course helped your Ph.D. studies?

Answer	Count	Percentage
Answer	4	71.43%
No answer	2	28.57%

Responses:	Integration. If you do not do languages, it is not possible to stay in the country after, I mean, in the healthcare domain.
	This course helped me to think about how I might communicate the ideas from my PhD studies to a broader audience.
	Creating websites in python to demonstrate my research results.
	By improving my programming skills.

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	By having a deeper understanding in my area of interest.

36. You answered positively in question f above, how do you believe the course helped your career?

Answer	Count	Percentage
Answers	8	88.89%
No answer	1	11.11%

Responses:	It was useful to understand the trajectory another individual took as I could see myself on a similar path. I wanted to understand the effects of leaving academia and opportunities for improving my work patterns.
	It was interesting to hear about different career opportunities within Academia... more research-oriented opportunities versus combination of research and teaching. Collaboration with industry (particularly from a research perspective) was also mentioned, but only slightly.
	Networking was the most important part of this course.
	I feel that having some knowledge or exposure to the area of intellectual property is valued by employers both within and outside of academia.
	I work as a clinician as well as pursuing a PhD. This course helped me with the clinical side of my career.
	The Django framework is in high demand in job offerings.
	Python is a very useful tool for data analysis. I believe that I'm going to use python throughout my career as a researcher.
	It was an opportunity to meet other researchers and create a network of colleagues.

37. What would you change in the course?

Answer	Count	Percentage
Answer	9	69.23%
No answer	4	30.77%

Responses:	More guest speakers, better engagement between the speaker and the audience, more activities to understand the transition that takes place.
	NA
	I think it was a good overview. Ok for an introductory workshop, and good for networking opportunities for an early-stage researcher or PhD student.
	I would change the contents, which were too general and not practical.
	Longer time on the practical aspect
	I don't know.
	I would extend the topics of the course by adding some extra teaching hours.
	The contents should have been more specific and practical.
	nothing

38. Describe a course that you believe you should have taken in order to help you with your career but for any reason, you didn't.

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Answer	Count	Percentage
Answer	6	46.15%
No answer	7	53.85%
Responses:	Time management (mental health for PhDs), **HOW TO SAY NO**.	
	Business related courses	
	I do not have any idea in this regard.	
	I don't know.	
	I should have taken a course on the topics of scientific writing and scientific presentation.	
	Writing Skills	

Section 7: Course-specific Structure Questions
The following questions aim to obtain information about the structure, timing, interaction, accessibility, and grading of this specific course.

39. How is the course delivered?

Answer	Count	Percentage
Included in standard program (e.g., performed periodically every semester)	4	30.77%
On-demand (performed upon request)	6	46.15%
Other	3	23.08%
Other Responses:	half-day workshop structure Once a year Weekend Course	

40. How long did it last?

Answer	Count	Percentage
1 day or less	3	23.08%
1 week or less but more than one day	**5**	38.46%
1 month or less but more than a week	2	15.38%
< 3 months	2	15.38%
3-6 months	0	0.00%
>6 months	1	7.69%

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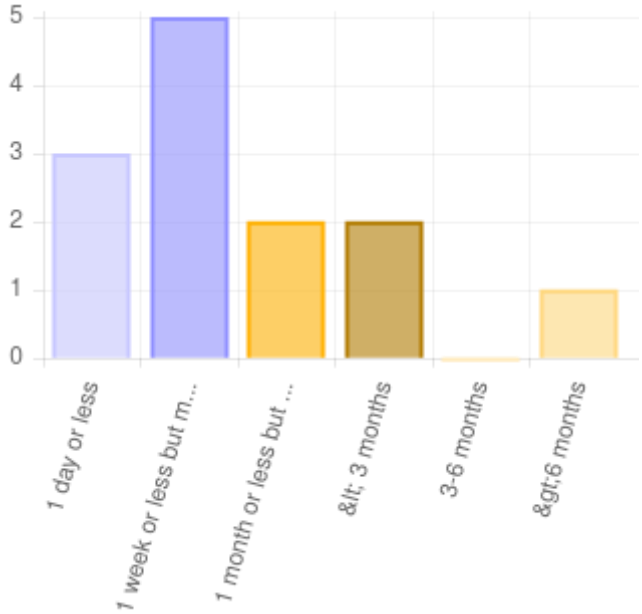

41. Did you have to pay a fee to attend?

Answer	Count	Percentage
Yes	3	23.08%
No	10	76.92%

42. How was the course structured?

Answer	Count	Percentage
Lectures	**12**	92.31%
Offline material without lectures (e.g., books, instructions, etc.)	2	15.38%
Projects	6	46.15%
Hands-on experience	6	46.15%
Other	1	7.69%
Responses:	panel discussion & Q&A session	

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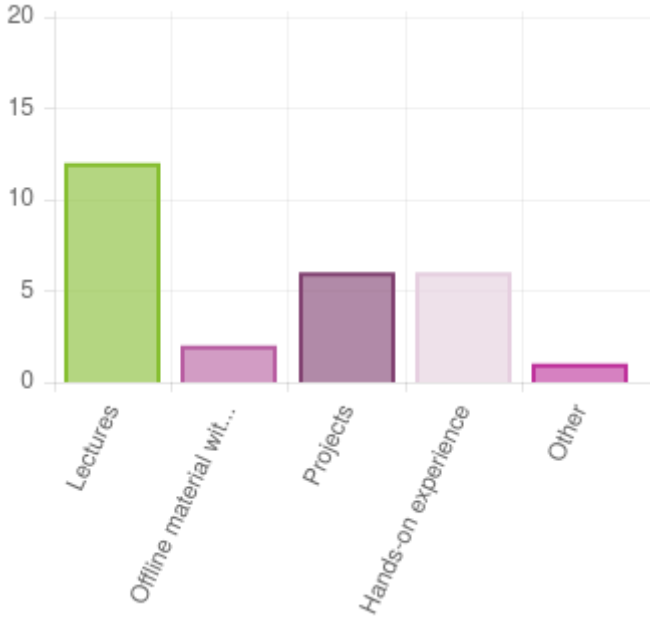
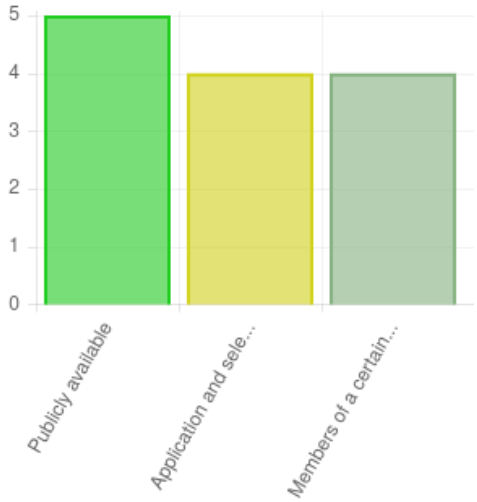


43. What was the level of interaction?

Answer	Count	Percentage
Physical presence in class	**9**	69.23%
Remote synchronous studies	1	7.69%
Remote asynchronous studies	4	30.77%
Periodic evaluation appointments	0	0.00%
No interaction	0	0.00%

44. How was the course available?

Answer	Count	Percentage
Publicly available	5	38.46%
Application and selection	4	30.77%
Members of a certain faculty/university/research center/ PhD program	4	30.77%



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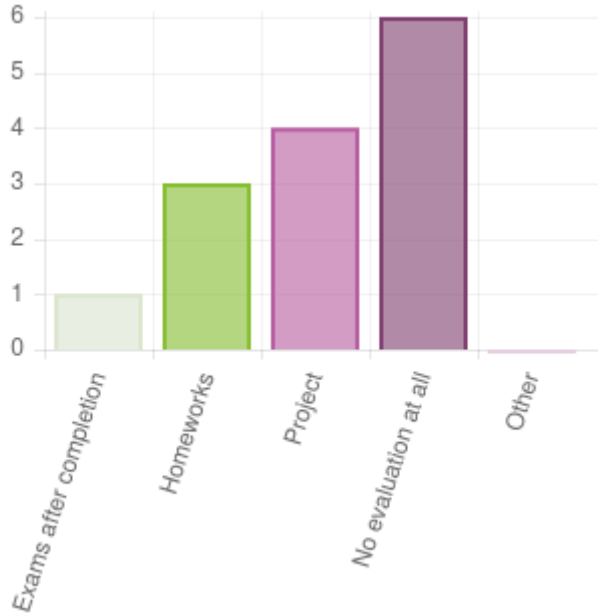
45. What was the grading method?

Answer	Count	Percentage
Exams after completion	1	7.69%
Homeworks	3	23.08%
Project	4	30.77%
No evaluation at all	6	46.15%



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46. You have selected Homeworks as the grading method, what type of Homeworks were they?

Answer	Count	Percentage
Individual	3	100.00%
Group	1	33.33%

47. You have selected Project as the grading method, what type of project was it?

Answer	Count	Percentage
Individual	2	50.00%
Group	3	75.00%

48. Does this course provide ECTS credits?

Answer	Count	Percentage
Yes	4	30.77%
No	**8**	61.54%
No answer	**1**	7.69%

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Appendix IV: Detailed Survey Results, Program Directors

Section 1: General Questions

1. Have you participated in the design or coordination of any courses at the Ph.D. level?

Answer	Count	Percentage
Yes	8	100.00%
No	0	0.00%

2. What type of courses did you organize?

Answer	Count	Percentage
Internal courses integrated in the Ph.D. program.	7	83.33%
External learning activities (seminars/workshops/summer schools etc.)	6	66.67%

Section 2: Internal Ph.D. Courses

This block of questions aims to obtain general information about the internal Ph.D. courses in your department or university.

3. Is there any involvement from non-academic tutors/speakers in the courses?

Answer	Count	Percentage
Yes	3	42.86%
No	4	57.14%

4. In what capacity?

Answer	Count	Percentage
Tutors	1	33.33%
Guest speakers	2	66.67%
Case studies	0	0.00%
Site visit	1	33.33%

5. In what disciplines?

Answer	Count	Percentage
Medicine	1	33.33%
Therapy and rehabilitation	1	33.33%
Inter-disciplinary programs and qualifications involving health and welfare.	1	33.33%

Section 3: External Learning Activities

This block of questions aims to obtain general information about the external courses that you are involved in or are available in your department/university.

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6. Were you involved in the coordination or design of interdisciplinary activities?

Answer	Count	Percentage
Yes	4	66.67%
No	1	16.67%
No answer	1	16.67%

7. In what disciplines?

Answer	Count	Percentage
Education not elsewhere classified.	1	25.00%
Medicine	1	25.00%
Inter-disciplinary programs and qualifications involving engineering, manufacturing and construction.	1	25.00%
Inter-disciplinary programs and qualifications involving health and welfare.	1	25.00%

8. Would you advise Ph.D. students to attend courses/activities outside the Ph.D. program?

Answer	Count	Percentage
Yes	5	83.33%
No	0	0.00%
No answer	1	16.67%

9. How do you believe that this choice could benefit them?

Answer		Count	Percentage
Answers		4	80.00%
No answer		1	20.00%
Responses:	Broadens the scope of viewing the world, encourages thinking outside the box.		
	It opens new networks, new ways of thinking and exposes them to contrary perspectives which may seed new research ideas or help them to better defend and explain ideas that they already have.		
	Networking opportunities See how their research will fit into the world outside the university. See what real world challenges are.		
	The majority of PhD students will not work in an academic setting and need to gain experience of topics and aspects of working that are important in industry and other non-academic centers.		

Section 4: Specific Course

From now on you will answer the following questions for a specific course that you find useful in terms of broadening students' career prospects outside Academia.

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10. Have you participated in the design of an inter-sectoral (which involves participation outside academia) course that was useful in terms of broadening students' career prospects outside Academia?

Answer	Count	Percentage
Yes	3	37.50%
No	5	62.50%

11. Have you participated in the design of any other course that was useful in terms of broadening students' career prospects outside Academia?

Answer	Count	Percentage
Yes	0	0.00%
No (N)	5	100.00%

Section 5: Course-specific General Questions
This block of questions aims to obtain general information about the specific course that you choose to talk about (Title, Context, type, academic/non, intersectoral, interdisciplinary).

12. What was the title of the learning activity/course that you found more useful for broadening students' career prospects outside Academia? &
13. Describe the content of this course. &
14. Provide the link of the course if available.

Title	description	Link
Critical appraisal of the literature	Formulation of the research question Formulation of research question, formulation of search strategy, bibliographic databases Searching bibliography principles	https://mrm.med.auth.gr/courses/compulsory/clinical-research-methodology/
Collaborative Writing	Forming writing groups of students from the multiple disciplines that contribute to connected health research and facilitating discussions to generate common research topics that may lead to an academic paper.	-
Interdisciplinary learning through problem-based learning in the Clinical Environment	The course presents interdisciplinary student groups with opportunities to discuss specific patient cases. Each of the individuals	-

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	within the group brings their own disciplinary knowledge to the table.	

15. Was it external (outside the Ph.D. program) or internal (as part of the Ph.D. program)?

Answer	Count	Percentage
External	3	100.00%
Internal	0	0.00%

16. What type of external activity?

Answer	Count	Percentage
Seminars/webinars	0	0.00%
Conferences	0	0.00%
Summer schools	1	33.33%
Course, outside of a Ph.D. program	0	0.00%
Other	2	66.67%
Responses:	MSc	
	Clinical Problem Based Learning	

17. Who was involved in the following activities of the course?

	Academia	Industry	**Non-Profit Organizations**	**Government / Policy**	**Professional Organizations**
Design	**3**	**1**			
Teaching	**3**	**1**			
Consulting	**1**	**1**			
Delivery	**2**	**1**			
Guest speakers	**1**				
On-Site Visit	**2**	**1**			

18. Was the course interdisciplinary?

Answer	Count	Percentage
Yes	3	100.00%
No	0	0.00%

19. What disciplines were included?
    - Medicine, Engineering
    - Social sciences, ICT, engineering, medicine
    - Medicine, Nursing, Physiotherapy, Education Technologist, Education Developer

20. What was the main discipline of the course?

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Section 6: Course-specific Satisfaction Questions
The following questions aim to obtain information about the aim, evaluation, students' selection, satisfaction of the specific course.

21. What was the aim of the course?

Answer	Count	Percentage
Developing Deeper understanding	2	66.67%
Developing knowledge	2	66.67%
Developing specific skills	3	100.00%

22. Please define (e.g., intellectual property, presentation skills etc.)

Answer	Count	Percentage
Answer	2	66.67%
No answer	1	33.33%
Responses:	Collaborative writing skills	
	Problem solving skills, Interdisciplinary knowledge, Clinical reasoning.	

23. Why do you think that this course is useful for broadening PhD students' career prospects outside Academia?

Answer	Count	Percentage
Answer	2	66.67%
No answer	1	33.33%
Responses:	I think it offered triangulation on a problem that better reflects the real-world collaboration necessary to solve connected health challenges which inevitably span more than one discipline or sector.	
	MSc course but could design equivalent for PhD students.	

24. What percentage of the participants complete the course on average?

Answer	Count	Percentage
90 %	1	33.33%
100 %	2	66.67%

25. Did attendees were given an opportunity to evaluate or provide feedback on the course?

Answer	Count	Percentage
Yes	2	66.67%
No	0	0.00%
No answer	1	33.33%

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26. Please answer the following questions on a scale from 1 to 5, where 5 is very positive and 1 is very negative.

	1	2	3	4	5	Arithmetic mean
What was the evaluation of the course?			1		1	4
What was your satisfaction with the course?			1		1	4

27. Please answer the following questions.

	Worse	The same	Better
How was the course evaluated compared with the other courses of your faculty?	**1**		**1**
How was the students' participation compared with the other courses of your faculty?		**1**	**1**

28. In what level did the following attributes do you believe make this course attractive to students on a scale of 1 to 5, where 1 is not at all and 5 very much?

	1	2	3	4	5	Arithmetic mean
Duration and time placement of the course					3	5
The structure			1	1	1	4
Networking opportunities				1	1	4.5
Travel opportunities			1		1	4
Interdisciplinarity				1	2	4.67
Intersectionality	1		1		1	3
The teaching/learning strategy		1		1	1	3.67
The assessment strategy	1			1		2.5
Other reasons						0

29. What would you change in the course?

Answer	Count	Percentage
Answer	2	66.67%
No answer	1	33.33%
Responses:	Spend more time explaining the learning goals up front and spread the activity over a longer period of time where the group collaborates at intervals.	
	Broaden the range of disciplines involved in the course.	

30. Describe a course that you wanted to organize in order to help your students with their career but for any reason, you didn't.

No answer

Section 7: Course-specific Structure & Design Questions

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The following questions aim to obtain information about the design, structure, timing, interaction, accessibility, and grading of this specific course.

31. How is the course delivered?

Answer	Count	Percentage
Included in standard program (e.g., performed periodically every semester)	2	66.67%
On-demand (performed upon request)	1	33.33%

32. How long did it last?

Answer	Count	Percentage
1 day or less	1	33.33%
1 week or less but more than one day	0	0.00%
1 month or less but more than a week	0	0.00%
< 3 months	2	66.67%
3-6 months	0	0.00%
>6 months	0	0.00%

33. Do you consider that this course is more valuable for students in their early or late studies?

Answer	Count	Percentage
Early	0	0.00%
Intermediate (between year 1 and 2)	2	66.67%
Late (>year 2)	2	66.67%
Multiple stages	0	0.00%

34. Was there a fee to attend the course?

Answer	Count	Percentage
Yes	0	0.00%
No	2	66.67%
No answer	1	33.33%

35. How was the course structured?

Answer	Count	Percentage
Lectures	1	50.00%
Offline material without lectures (e.g., books, instructions, etc.)	1	50.00%
Projects	1	50.00%
Hands-on experience	2	50.00%

36. What was the level of interaction?

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Answer	Count	Percentage
Physical presence in class	3	100.00%
Remote synchronous studies	1	33.33%
Remote asynchronous studies	1	33.33%
Periodic evaluation appointments	1	33.33%
No interaction	0	0.00%

37. How was the course available?

Answer	Count	Percentage
Publicly available	0	0.00%
Application and selection	1	33.33%
Members of a certain faculty/university/research center/ PhD program	2	66.67%

38. Regarding the availability of the courses that you are involved in, is the majority open or restricted?

Answer	Count	Percentage
Open	1	33.33%
Restricted	2	66.67%

39. How were the students graded?

Answer	Count	Percentage
Exams after completion	0	0.00%
Homeworks	0	0.00%
Project	1	33.33%
No evaluation at all	1	33.33%
Other: Continuous assessment by tutors	1	33.33%

40. You have selected Homeworks as the grading method, what type of homeworks were they?

Answer	Count	Percentage
Group	0	0.00%
Individual	0	0.00%

41. You have selected Project as the grading method, what type of Project was it?

Answer	Count	Percentage
Group	0	0.00%
Individual	1	100.00%

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