mindSET
European Transferable Skills Training Demands Survey – Analysis Report

Training the mindSET –

Improving and Internationalizing Skills Trainings for Doctoral Candidates

Contents

I. Introduction

The development of a European Core Curriculum in Transferable Skills for doctoral candidates in Science, Engineering and Technology (SET) Disciplines and training material for its different modules is the main objective of the project "Training the mindSET – Improving and Internationalizing Skills Trainings for Doctoral Candidates". The curriculum answers to the growing demands to prepare doctoral candidates for diverse professional contexts, inside as well as outside academia. Employability arises from a number of competences gained during (and after) one's studies. Thus, doctoral trainings contribute to employability by responding to the demands of the labour market in the best possible way and by translating them into curricula. Therefore, the first step in designing an effective curriculum is to determine the training needs in transferable skills of PhD candidates.

This document refers to the results of the analysis of potential training needs for SET PhD candidates in Europe. The methodological approach used for the study design is two-fold. The database of the needs analysis is comprised of a short **survey** amongst PhD candidates at all partner universities[1] on their training needs (**primary data**) and an **analysis of existing research** on skills demands of different employment markets and for different career paths within Europe (**secondary data**), whereby both pieces of research feed into this summarising report.[2]

In general, this report of the mindSET European Transferable Skills Training Demands Survey aims at providing an overview of the results of the primary and secondary research conducted. In particular, within the scope of the mindSET project, these results determine the relevance of particular competence areas and indicate whether it would be beneficial to include these into the curriculum.

Therefore, this needs analysis report also helps to answer the following questions: which competences of PhD candidates need to be strengthened and should, hence, be fostered in doctoral trainings and why? Obviously, the competence areas that are most required need to be reflected in the modules of the curriculum.

In this way, it serves as a communication tool for all parties involved at the participating partner universities. However, it also addresses supervisors, graduate schools and training centres of other European Technical Universities (TUs) that are potentially interested in implementing the curriculum for their SET PhD candidates. Besides presenting the survey results, this needs analysis provides insights into the methodological aspects of curriculum development.

The groundwork undertaken in the first step was primary and secondary research on the demands and gaps in transferable skills, as recognised by European SET PhD candidates and employers. Assessing current frameworks and models led to the conclusion that none of them covered the required competence demands in transferable skills for all potential career paths in- and outside academia sufficiently. Therefore, based on these findings, a European competence model was developed in the second step by the Centre for Scientific Continuing Education and Cooperation (ZEWK) of TUB. The model compiles a set of transferable skills recommended to be possessed by European PhD candidates and researchers specifically in SET disciplines. [3]

The structure of this report is composed as follows: after a brief introduction, the results of the primary research can be found in chapter II, which presents the training demands of PhD candidates, while the findings from secondary research are summarised in chapter III, which refers to

[1] The project is implemented by four strategic partners, namely the Norwegian University of Science and Technology (NTNU), Politecnico di Milano (PoliMi), Warsaw University of Technology (WUT) and Technische Universität Berlin (TUB).
[2] The instrument to conduct the survey among was an online questionnaire. The full questionnaire can be found in the annex of this report. Programming, data collection and evaluation was done by applying the software "SPSS".
[3] For a more detailed description of the model, see chapter III.3.

skills and competences required by different employers. Chapter IV contains the conclusion, which will be included for the curriculum.

II. Training demands of PhD candidates

The most significant information is surely provided by the European SET PhD candidates themselves who have answered the questionnaire of the mindSET European Transferable Skills Training Demands Survey. As the project´s primary target group they know best what transferable skills and competences they need to enhance their employability in- and outside academia. Although the literature analysis provides more representative data, it is not necessarily focused on SET disciplines and also includes other industries.

The questionnaire design followed an established multi-step approach. First, it was drawn on current competence frameworks and competence models, such as the HIS graduate survey[4] (2004) on subject-specific and generic transferable skills and competences of engineers and computer scientists, the Researcher Development Framework (RDF) developed by Vitae (2011), the competence atlas of the University Association for the Qualification of Junior Researchers in Germany (UniWiND)[5] (2016), the transferable skills matrix of the European Council of Doctoral Candidates and Junior Researchers (Eurodoc) (2018) or the research profile descriptors, published by the European Commission (2019). These were applied to the distinct task requirements that PhD candidates are facing when pursuing distinct career paths in employment markets in- and outside academia.

In this way, the partner universities decided on the following key competence areas to be included in the questionnaire:

- acquiring third party funds and projects
- time and project management
- teaching methods
- cooperation, communication and presentation
- entrepreneurial thinking
- leadership and management
- publication, promotion and transfer of research results and
- research ethics and good scientific practice.

Second, the afore mentioned eight competence areas (which are to be reflected as modules in mindSET´s European Core Curriculum in Transferable Skills) were then sub-divided into 39 individual transferable skills and competences to gather more detailed data about the training needs of SET PhD candidates in Europe. Third, the preliminary version of the questionnaire underwent two rounds of partner feedback before the final version was programmed online.[6]

In the questionnaire, the training needs for different competence areas of transferable skills were covered through a closed and an open question. The closed question “I would be interested in attaining a training course on the following subject…” listed individual transferable skills and competences for doctoral students as single items that could be rated on a 5-point Likert-scale from 1 ("I don´t agree at all") to 5 ("I fully agree"). The open question “Are there any further topics you either

[4] Cf. Minks (2004).
[5] Cf. Vurgun (2016).
[6] The survey was conducted between 14th January 2019 and 11th February 2019.

wish training or coaching for?" aimed at identifying additional competence areas or individual competences and, thus, at training needs of PhD candidates that had not been covered so far.[7]

Based on the questionnaire results, we can provide answers to the question which transferable skills and competences are most needed as seen from the perspective of European SET PhD candidates. The study shows the following **competence areas** as the most essential competences, which are displayed in table 1.[8]

Rank	Competence Area	I fully and I rather agree Total percentages (N)	I fully agree Total percentages (N)
1	Acquiring third party funds and projects	76,6% (330)	38,5% (166)
2	Cooperation, communication and presentation	72,2% (312)	28,5% (166)
3	Leadership and management	64,0% (276)	29,2% (126)
4	Time and project management	63,4% (274)	26,4% (114)
5	Publication, promotion and transfer of research results	63,0% (273)	19,6% (85)
6	Teaching methods	59,7% (258)	21,8% (94)
7	Research ethics and good scientific practice	54,8% (236)	21,3% (92)
8	Entrepreneurial thinking	54,4% (235)	19,9% (86)

Table 1: Responses "I would be interested in attending a training course on the following topic…", clustered according to competence areas, ranked according to importance of competence areas (Q1, mindSET questionnaire on qualification needs amongst European PhD candidates), N=437

Legend of graphs:

[7] Across all countries, very few additional comments were made in this section. This indicates good coverage of the suggested competence areas and individual transferable skills and competences. The majority of the few comments stated expressed singular opinions and thematic overlaps. However, competences in "research methods" and "self-management" were mentioned here, discussed and, finally, included into the pool of competences to be included in the curriculum.

[8] Besides doctoral candidates as primary target group (N=91 (TUB), N=120 (NTNU), N=62 (WUT) and N=164 (PoliMi)), NTNU extended the survey to post doc candidates (N=27), WUT to faculty heads (N=3) and PoliMi to faculty members (N=97). For the results of the extended database, please contact the respective partner university.

These values demonstrate a high demand for training needs among EU SET PhD candidates in transferable skills in all competence areas. However, there are certain focal points.
Firstly, it is no coincidence that competence areas such as

- acquiring third party funds and projects (1)
- cooperation, communication and presentation (2)
- leadership and management (3)
- time and project management (4)

are the most required areas. Most of these competences are needed directly in the phase in which the SET PhD candidates currently find themselves – either for the dissertation itself or for research tasks that they may perform in a job. Acquiring third-party funds, implementing projects, presenting oneself to others and networking – these are all typical challenges in the doctoral phase. These are competences with a high direct application and practical relevance.

Leadership and management as third-placed competence area in the ranking is interesting. This means that SET PhD candidates already anticipate future leadership positions in this phase. Obviously, this is true for many who, therefore, see a high demand for further training.

The values for the competence areas

- publication, promotion and transfer of research results (5)
- teaching methods (6)
- research ethics and good scientific practice (7) and
- entrepreneurial thinking (8)

suggest lower demands.

Conversely, teaching methods´ ranking in 6th place merely shows that either a comparatively small number of the SET PhD candidates interviewed are interested in a career with teaching tasks or that they underestimate the demands on teaching. Nevertheless, this competence is extremely important for those who want to strive for a career in teaching.

With regard to the competences attributed to the field of research ethics and good scientific practice, PhD students may not quite see their direct application relevance – although these competences are absolutely fundamentals and are part of the compulsory programme of every continuing education programme for transferable skills.

In order to understand the transferable skills and competence demands for the area of entrepreneurial thinking, you have to be able to imagine being self-employed while still at this early stage. The fact that, nevertheless, more than half of the respondents indicate a need for further training in this area is in itself astonishing. As such, against this background the value is to be rated as high (even if these competences seem to be least required in comparison to the other).

The subsequent figures 1 to 8 offer a different perspective of analysis. They display the results for all 39 individual transferable skills and competences for SET PhD candidates across all competence areas and participating universities separately. It was again drawn on the summated proportions of candidates who expressed their consent by answering Q1 with “I fully agree” and “I rather agree”. The results served as an indicator for the demands of particular transferable skills and competences and, hence, for their relevance to be included for the curriculum.

Intriguingly, for 36 of the 39 individual transferable skills covered by the questionnaire (approx. 90%), at least half of the participating SET PhD students identified a need.[9] Among the individual

[9] This means than at least 50% of PhD candidates answered Q1 with “I fully agree” or “I rather agree” (total percentages).

transferable skills most sought after are six that are required by two-thirds or more of the SET PhD survey respondents, with the top three required by about three-quarters or more of the survey respondents. Overall, these values suggest that there is a high demand for further training in transferable skills. For example, the top ranked transferable skill, effective academic and scientific writing, is sought after by 84% of the survey participants across Europe (see table 2).

Accordingly, there are very few outliers, such as the relatively low interest of SET PhD candidates to participate in transferable skills trainings on human resources management (overall summated share: 34,4%), despite their undisputed relevance for entrepreneurial success or for its importance in management positions, ethical questions that apply to research with dual-use implications (overall summated share: 41,4%) or assessment and grading (47,8%).[10]

The data also reveals country-specific differences in the perceived importance of particular competences.[11] These need to be seen both in the context of the characteristics of the respective PhD programmes and the national education systems.[12]

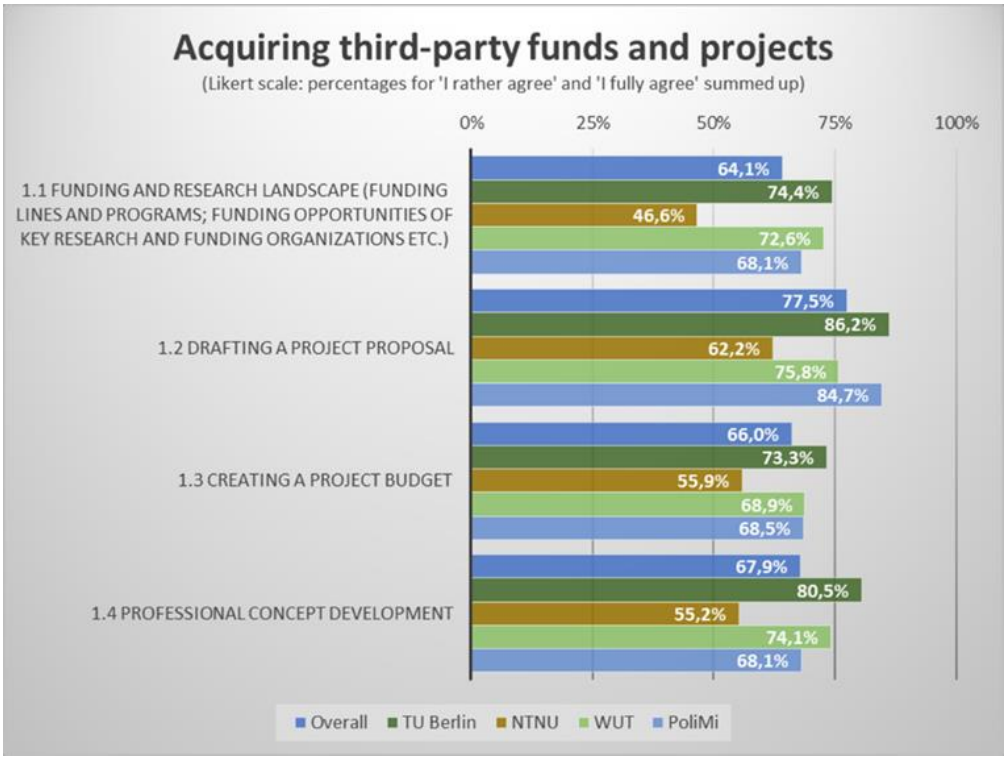

Figure 1: Results for module "Acquiring third-party funds and projects" per item across all partner universities and overall values. Source: own data.

[10] See figure 5, 8 and 2 respectively.

[11] For example, figure 1 shows that the interest of responding PhD students from NTNU in getting to know the funding and research landscape (which is part of the module "Acquiring third party funds and projects") is much lower (46,6%) compared to the other partner universities (68,1% at PoliMi, 72,6% at WUT and 74,4% at TUB, the latter of which accounts for +27,8 percentage points compared to NTNU). Figure 18 reveals that creating a project budget (same module) seems to be a very important training need for 47,5% of the respondents at WUT. However, this is only interesting for 27,1% of the respondents at NTNU.

[12] PhD programmes in Europe vary to a great extent - from the more independently pursued "apprenticeship model" to the more structured graduate school model.

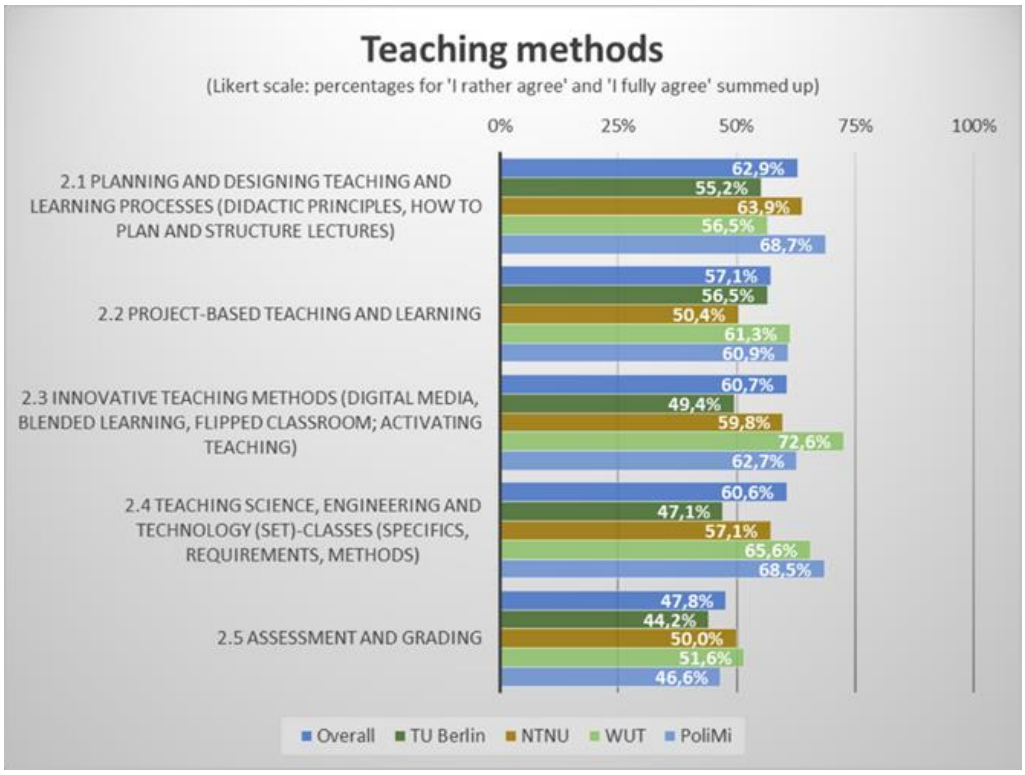

Figure 2: Results for module "Teaching methods" per item across all partner universities and overall values. Source: own data.

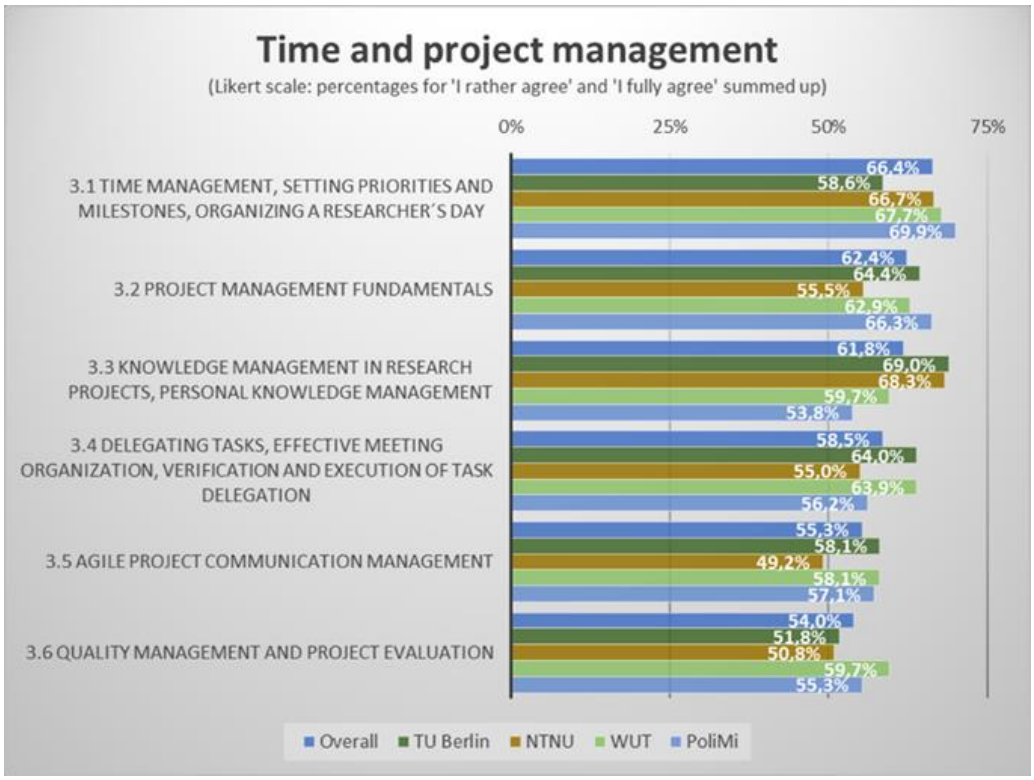

Figure 3: Results for module "Time and project management" per item across all partner universities and overall values Source: own data.

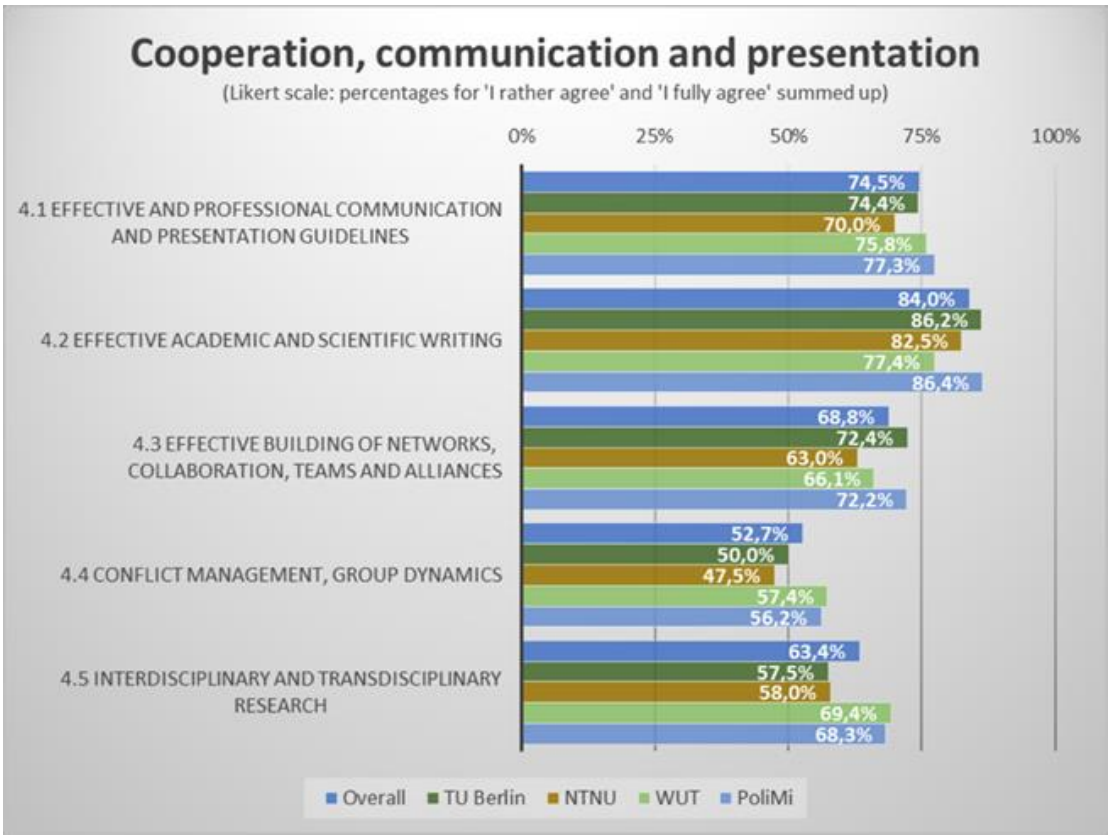

Figure 4: Results for module "Cooperation, communication and presentation" per item across all partner universities and overall values. Source: own data.

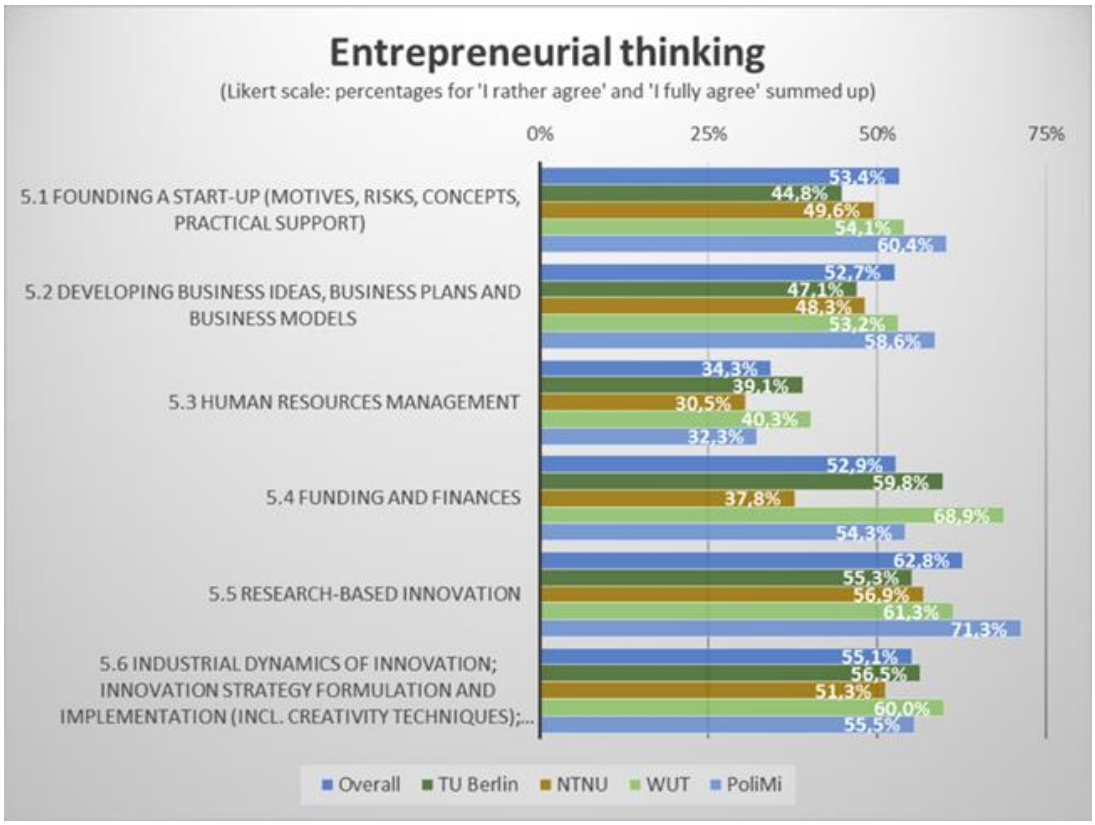

Figure 5: Results for module "Entrepreneurial thinking" per item across all partner universities and overall values. Source: own data.

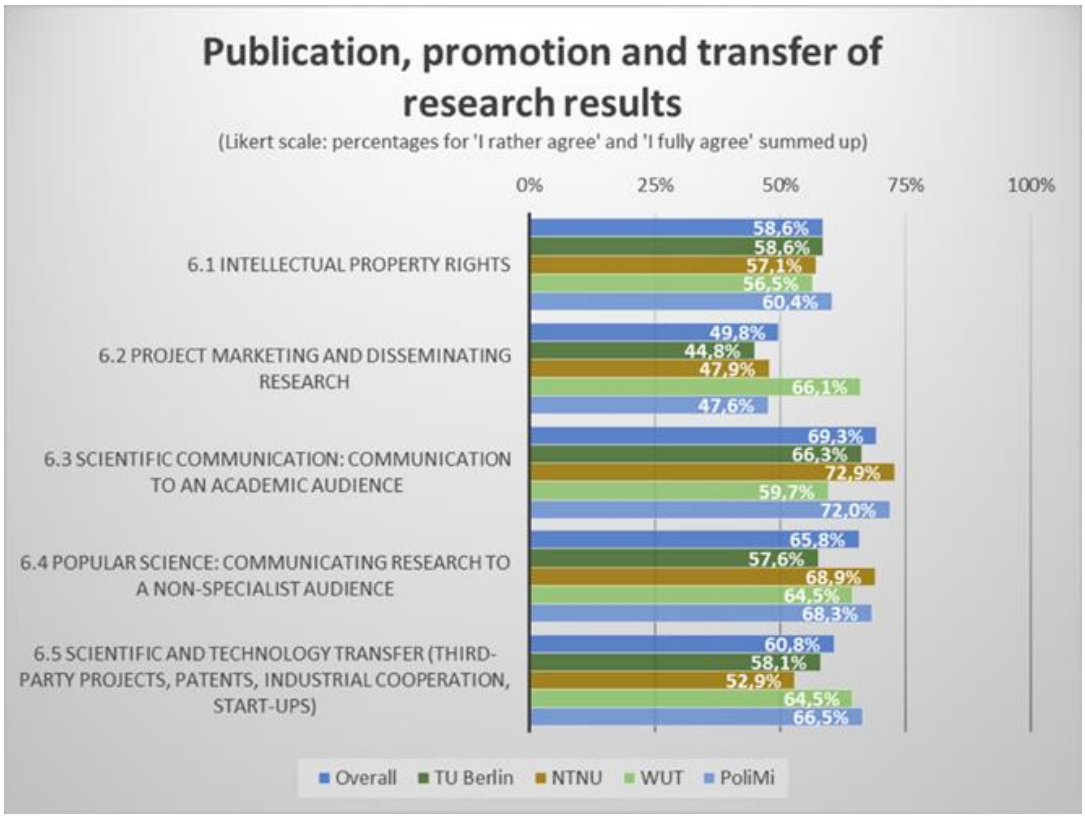

Figure 6: Results for module "Publication, promotion and transfer of research result" per item across all partner universities and overall values. Source: own data.

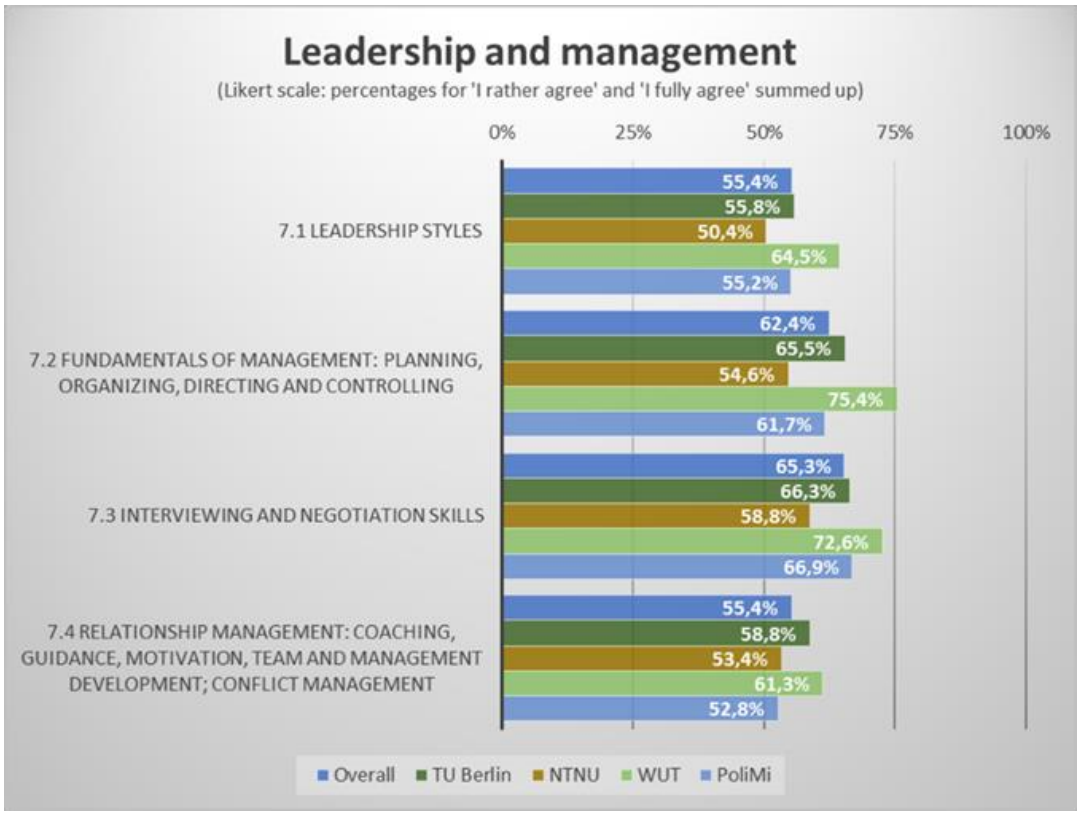

Figure 7: Results for module "Leaderhsip and Management" per item across all partner universities and overall values Source: own data.

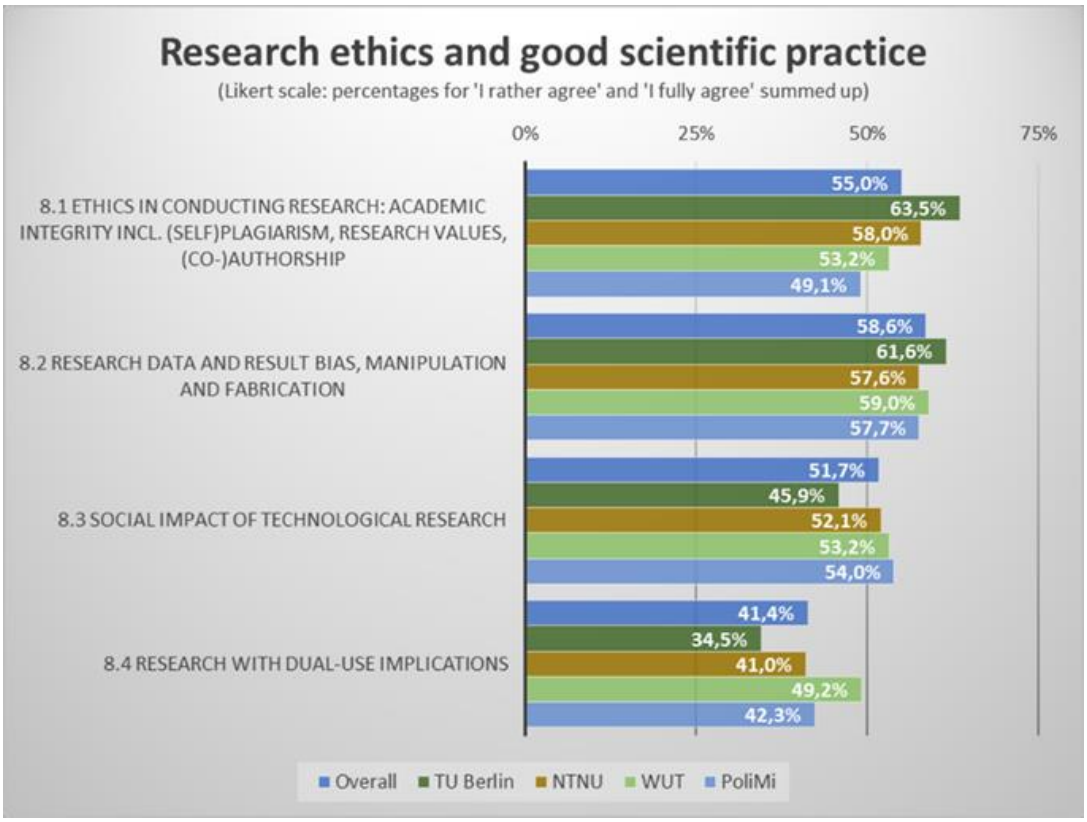

Figure 8: Results for module "Research Ethics and good scientific practice" per item across all partner universities and overall values. Source: own data.

The presented results uncover the top ten individual transferable skills and competences to be acquired in doctoral trainings that are most sought after by participating SET PhD candidates across all partner universities. These competences are displayed in the following table 2, ranked by the candidates´ questionnaire results for the answers to question Q1 "I fully agree" and "I rather agree" added up in percentages.[13]

[13] The competences are ranked according to the total percentages of participants answers "I fully agree" and "I rather agree" to the question "I would be interested in attending a training course on the following topic…" (Q1) of the mindSET European Transferable Skills Training Demands Survey.

Rank	Item / transferable skills and competences	Competence area	I fully and I rather agree Total Percentages
1	Effective academic and scientific writing	Cooperation, communication and presentation	84,0%
2	Drafting a project proposal	Acquiring third party funds and projects	77,5%
3	Effective and professional communication and presentation guidelines	Cooperation, communication and presentation	74,5%
4	Scientific communication: communication to an academic audience	Publication, promotion and transfer of research results	69,3%
5	Effective building of networks, collaboration, teams and alliances	Cooperation, communication and presentation	68,8%
6	Professional concept development	Acquiring third party funds and projects	67,9%
7	Time management, setting priorities and milestones, organising a researcher´s day	Time and project management	66,4%
8	Creating a project budget	Acquiring third party funds and projects	66,0%
9	Popular science: communicating research to a non-specialist audience	Publication, promotion and transfer of research results	65,8%
10	Interviewing and negotiation skills	Leadership and Management	65,4%

Table 2: Demands of the top ten individual transferable skills ranked by the total percentage of the answer to question Q1. Source: mindSET European Transferable Skills Trainings Demands Survey[14].

Looking at the top ten group of individual transferable skills with particularly high demand, it can be confirmed that the results referring to the **individual transferable skills and competences** are in line with the previous findings concerning the most essential **competence areas** (see table 1).

The following figures 9 to 18 offer another perspective by displaying the results for the ten transferable skills most required split by university.

[14] In 2018, NTNU conducted a survey among PhD candidates and supervisors at the faculty of Information Technology and Electrical Engineering to assess the specific demands of their PhD candidates in transferable skills trainings. The competence areas considered most interesting by the participants were ethics (now a mandatory module), researched-based innovation, didactics, communication and project management. The programme will start with the next academic year 2019/2020. The study concluded that the best way to offer trainings in transferable skill is to develop (at least) five modules in transferable skills whereof the candidates were to choose three modules.

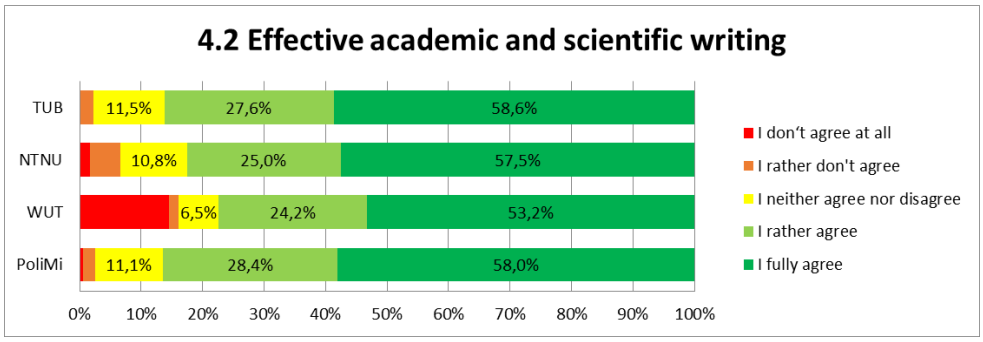

Figure 9: Results for item 4.2 "Effective academic and scientific writing", split by university. Source: own data.

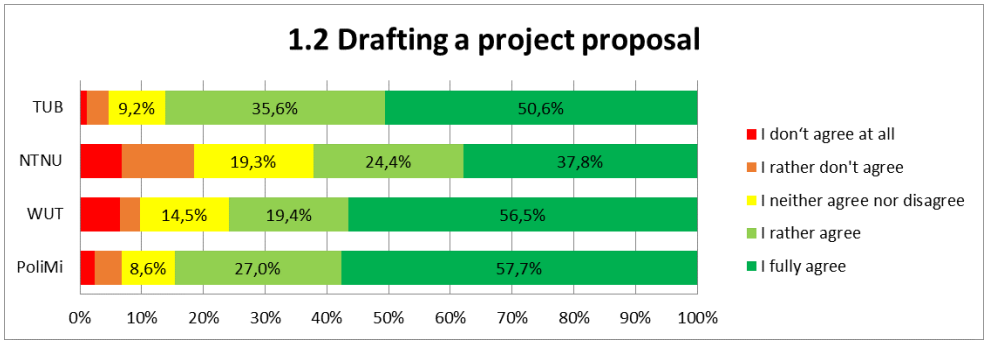

Figure 10: Results for item 1.2 "Drafting a project proposal", split by university. Source: own data.

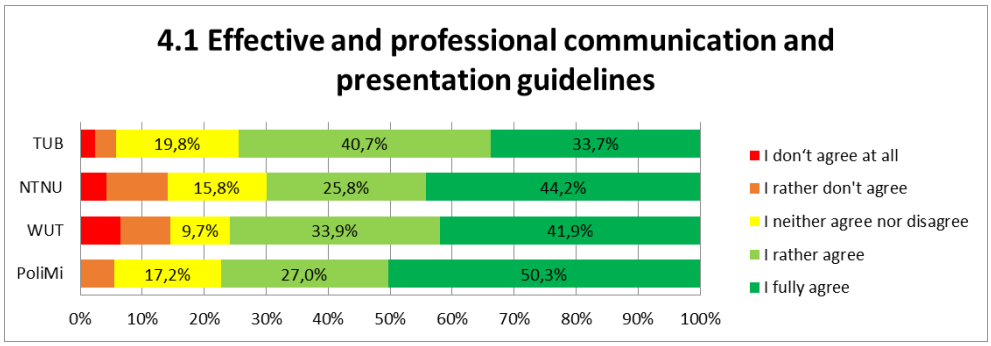

Figure 11: Results for item 4.1. "Effective and professional communication and presentation guidelines", split by university. Source: own data.

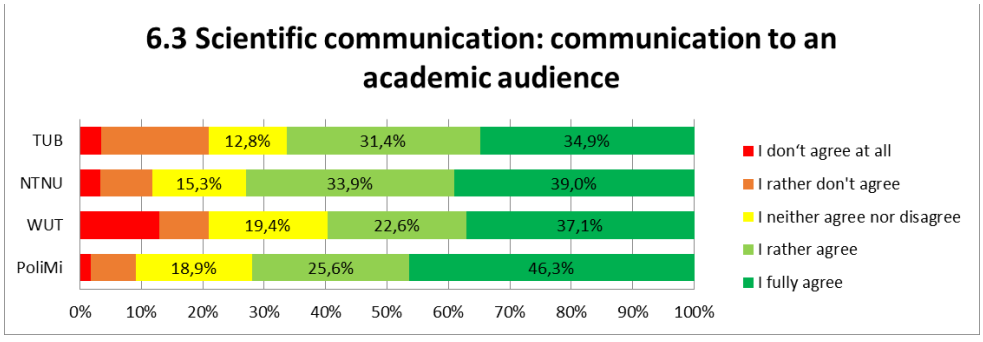

Figure 12: Results for item 6.3 "Scientific communication: communication to an academic audience", split by university. *Source: own data.*

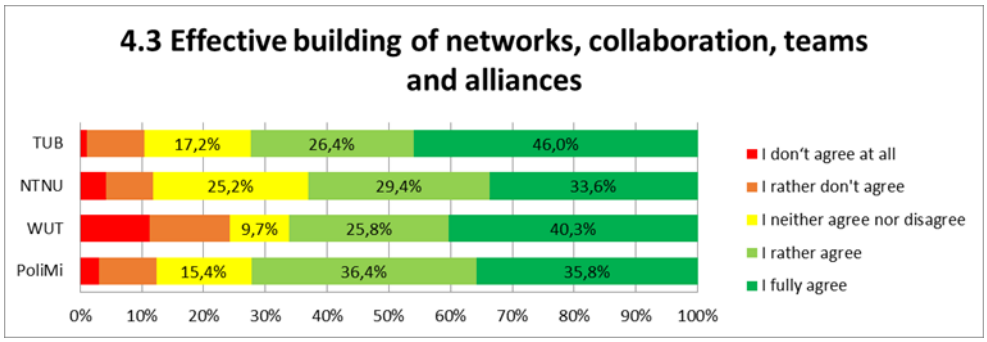

Figure 13: Results for item 4.3 "Effective building of networks, collaborations, team and alliances, split by university Source: own data

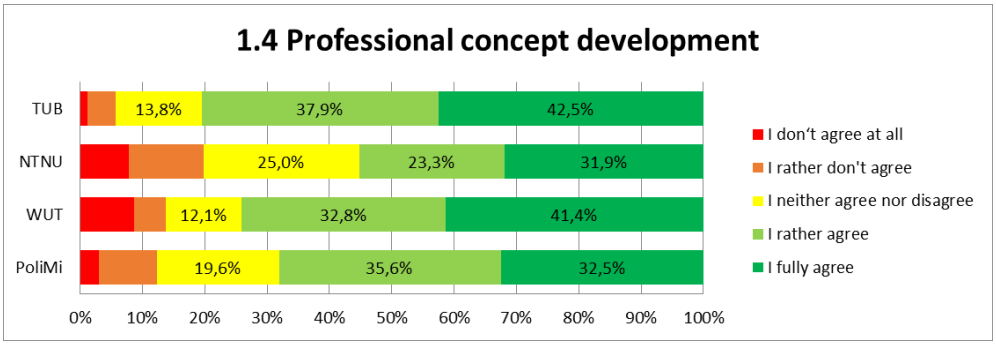

Figure 14: Results for item 1.4 "Professional concept development", split by university. Source: own data

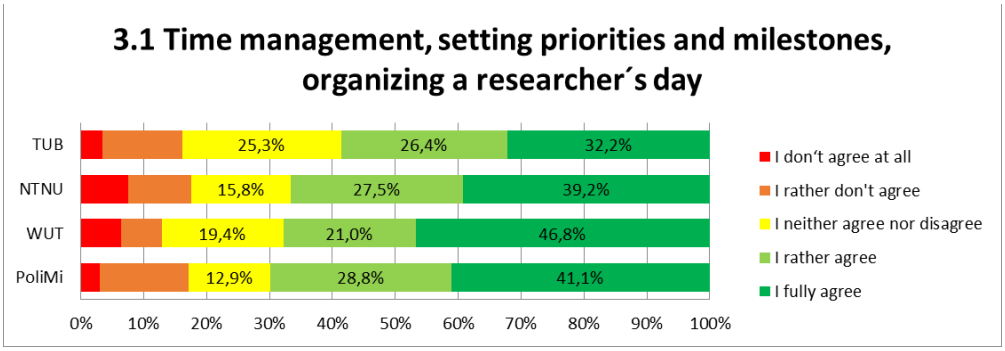

Figure 15: Results for item 3.1 "Time management, setting priorities and milestones, organizing a researcher´s day", split by university. Source: own data

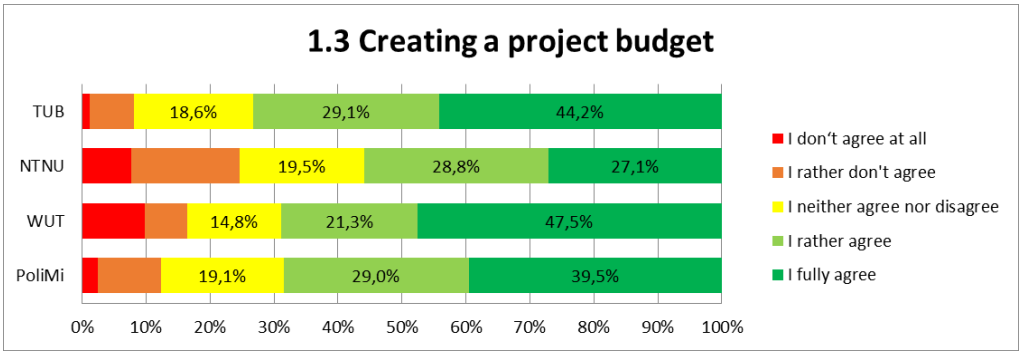

Figure 16: Results for item 1.3 "Creating a project budget", split by university. Source: own data

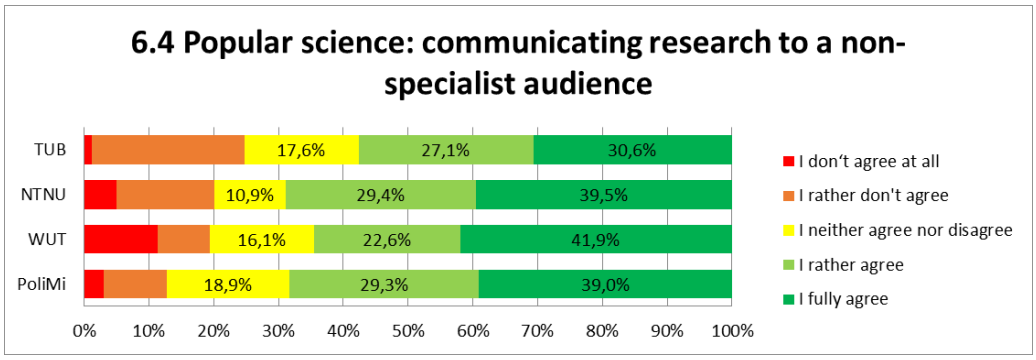

Figure 17: Results for item 6.4 "Popular science: communicating research to a non-specialist audience", split by university. *Source: own data.*

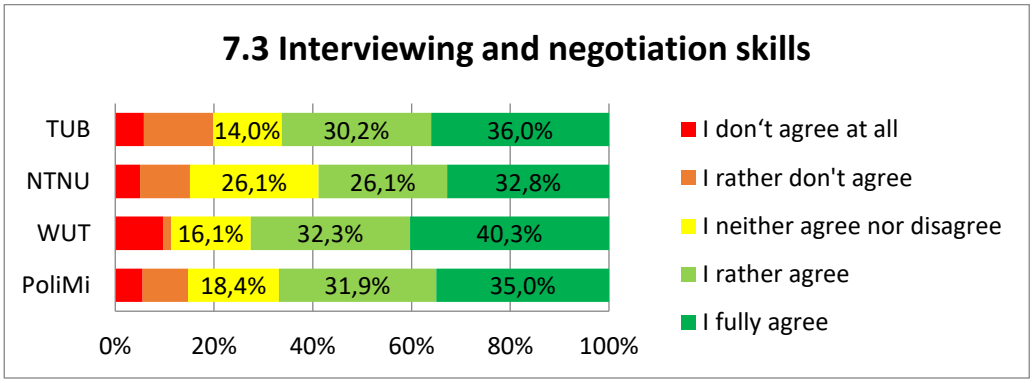

Figure 18: Results for item 7.3 "Interviewing and negotiation skills", split by university. *Source: own data.*

Generally, it can be noted that all individual transferable skills and competences provided in the questionnaire are required by SET PhD candidates who participated in the mindSET European Transferable Skills Training Demands Survey. Negative outliers, such as the relatively low interest in attending trainings in human resources management or in research with dual-use implications, were rare.

At the same time, three competences were sought after by the SET PhD candidates who participated in the survey, considered and, thus, added to the pool of competences to be included for the curriculum, namely research methods, self-management and gender biases[15]. While the first two topics emerged from participants´ open comments in the survey, the latter resulted from partner discussion.

[15] According to overall competence model for SET PhD students and graduates of ©ZEWK/TUB, diversity aspects are also treated as cross-sectional discipline that is always addressed and considered in all transferable skills trainings delivered. Further cross-sectional dimensions are internationalisation, governance and social responsibility (see figure 24).

III. Required skills and competences

III.1 Overview of relevant employment markets and career paths

As the development of a competence model translates requirements of the respective organisations into competence requirements for their employees, it is beneficial to gain an overview of the potential career options for SET PhD candidates and graduates. Across the entire employment market, there are different **career paths** for SET PhD students and graduates within a wide range of options within and beyond the university.

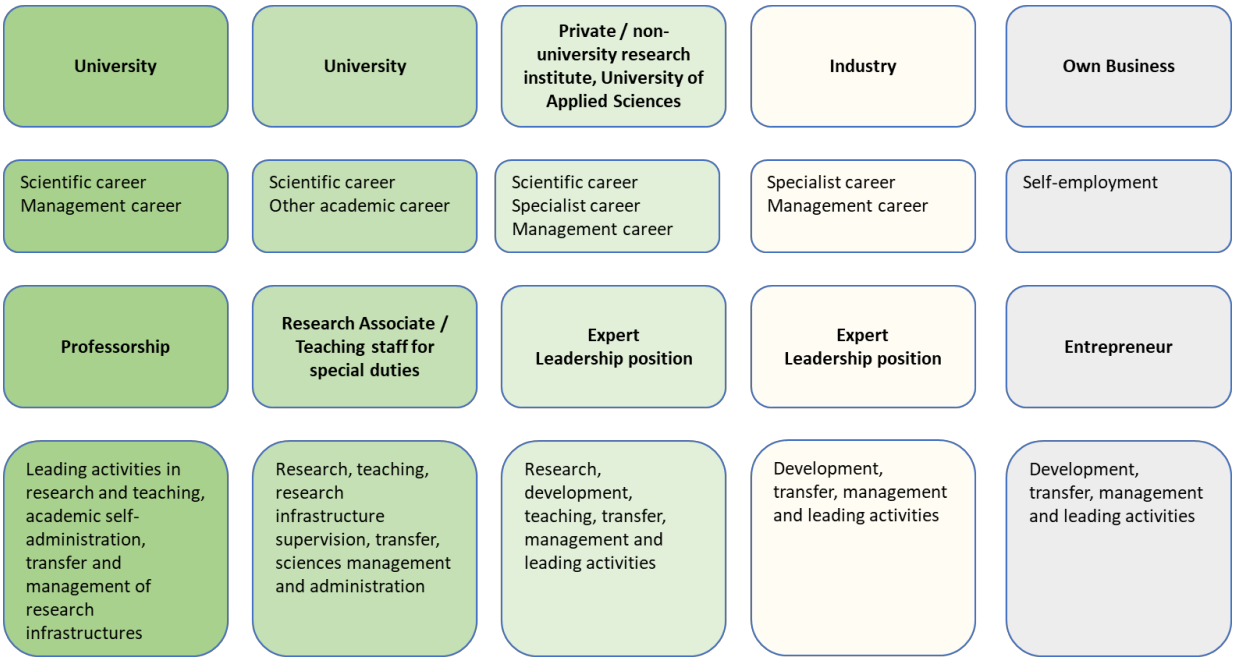

Figure 19: Different employment markets and typical career paths of PhD graduates within these markets (own figure)

According to different employment markets, the following ideal-typical **fields of employment** can be distinguished for SET PhD graduates:

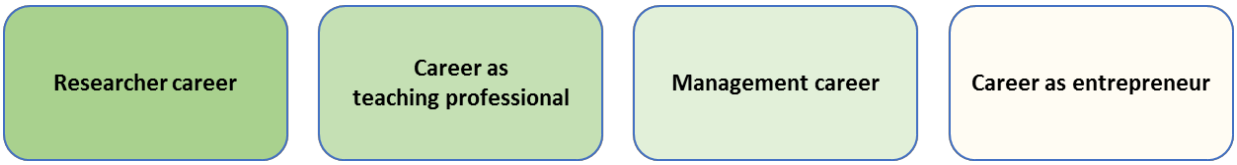

Figure 20: Ideal-typical fields of employment for PhD graduates (own figure)

In practice, those ideal-typical fields do not exclude but rather supplement each other within various combinations. Professors, for example, are active in at least three fields of employment – as researchers, teaching professionals and managers – and, in addition, partially as entrepreneurs.

To some extent, career paths still follow traditional patterns with clearly defined **career steps**. However, beyond those ideal types the variety of career paths expands with multiple hybrid combinations possible. Not every academic career concludes in a professorship. Careers, especially in the SET fields, may start in industry[16] and return to university or they might develop first in academic research and culminate in an innovative start-up. Even paths to professorships have become versatile

[16] Management careers in industry comprise careers in particular fields as well, such as advisory and consulting services. See also figure 25, competence profile 3.

and, today, post-doctoral qualification comes in different shapes. The number of persons going different career paths and attending a professorship grows. Figure 21 provides an overview of the career steps on the way to a professorship, leading researcher or manager in- and outside academia

Figure 21: Career steps on the way to a professorship, leading researcher or manager in- and outside academia (own figure)

From a quantitative viewpoint, different potential employment markets require extensive competences of doctoral candidates. Even though the proportion of PhD holders that pursue a career in academia is quite diverse across Europe, what can be observed is a growing trend towards a constantly decreasing percentage of researchers in SET domains who aim at lasting careers at universities.[17] They become "important actors in industry and other public and private sectors as well as entrepreneurs or leaders and `intrapreneurs´ in industry, government and other sectors. […] In Germany, approximately 90% of SET PhD graduates leave university immediately after completing their doctorate and start working in industry and other non-academic domains."[18] A rather small proportion remains at the university to qualify for a professorship or alternative position at university.[19] This is also reflected by career aspirations of young scientists: In Germany, less than half of them aspire a long-term academic career when starting their scientific employment. In engineering, this proportion is at 24%, whereas nearly two third of young scientists favour a researcher or development position in the industry.[20]

[17] See, for example, CESAER, CLUSTER, EuroTech Universities, IDEA League, Nordic Five Tech (2015); Wissenschaftsrat (2014) or NIFU (2017). At WUT, where an increasing number of PhD course participants is employed in the industry, the share of doctoral candidates to pursue an academic research career is also shrinking. However, there is no official quantitative data available.

[18] CESAER, CLUSTER, EuroTech Universities, IDEA League, Nordic Five Tech (2015), p. 6; cf. Wissenschaftsrat (2014), p. 21.

[19] Cf. Wissenschaftsrat (2015), p. 21

[20] Cf. Stifterverband, DZHW (2016), pp. 29 et seq. Values refer to a survey among junior researchers conducted in 2015 (N=3396).

However, these percentages vary from country to country and are also subject to the respective discipline. In Italy, for example, approximately 24% of PhD holders work in academia six years after graduation. One or two years after graduation, about 47% of SET PhD graduates from Politecnico di Milano held a position in academia.[21] In Norway, with 30% fewer doctoral candidates than previously aim at a research position at university. This is particularly true for the career ambitions of candidates in natural sciences, technology, medicine and health. For PhD candidates from technology/mechanical engineering or mathematics/natural sciences, the percentage lies at 22% respectively.[22]

III.2 Skills demands on employment markets

While the survey´s main objective was to identify the training needs in transferable skills and competences of SET PhD candidates across Europe, the **secondary analysis** was intended to find out more about the skills and competence requirements of employers within and beyond academia. By including their perspective, possible blind spots ought to be uncovered.

Even though the number of studies on skills demands for PhD candidates and graduates across Europe is scarce, particularly with regard to distinct employment markets and career paths, the existing research shows that transferable skills play a major role in businesses, the industry and diverse public and private sectors. This is indicated as well by the results of a study conducted by the Università Ca' Foscari Venezia (2017) that focused particularly on transferable skills for M.Sc. and PhD graduates entering the private sector. Researchers found that 62% of the participating companies declared that the selection of candidates was influenced to a great extent by the availability of transferable competences, especially at junior level.[23]

In addition, various studies indicate that the importance of transferable skills has grown considerably during the last decades and is most likely to grow further in the future. In Germany, some transferable skills – also called "key competences" or "soft skills" – have, in fact, never been demanded by the job market as much as nowadays. Across occupations at all levels and regardless which career path is chosen, employers emphasise the needs of generic skills.[24]

Those skills demands derive largely from changes in the world of work. Megatrends such as rapid technological change, digitalisation and internationalisation[25] as well as growing levels in project-based work, working in networks and in multidisciplinary teams, new team constellations and leadership [26], raising degrees of work complexity and intensification with more complex products and services[27], increasing levels of responsibilities and coordination, intensified communication and needs for cooperation[28] – all these factors have led to a significant shift of competence requirements.[29] In addition, against the background of the growing shortage of specialists, employers increasingly rely on

[21] Cf. ISTAT (2018), p. 1. Values refer to PhD holders (all specialties); Politecnico di Milano, Career Service and Study Services (2017), p. 1. Values refer to PhDs from mathematics and computer science and industrial engineering and information technology areas (graduated 2015 and 2016) (N=465).

[22] Cf. NIFU (2017), English abstract, pp. 4-5. https://nifu.brage.unit.no/nifu-xmlui/bitstream/handle/11250/2445865/NIFU-report2017-10-english-summary.pdf?sequence=6&isAllowed=y (20.05.2019). There are significant differences between subject fields. While 22% of PhD candidates from technology/mechanical engineering (n=577) or mathematics/natural sciences (n=724) aspire to obtain a research position at university, it is, for example, 61% from the humanities (n=353); (N=3654).

[23] Cf. Università Ca' Foscari Venezia (2017), online report. Sample: 90 local and international small and medium-sized enterprises (SMEs)

[24] Cf. BMAS (2017), pp. 36-37.

[25] Cf. Daheim, Wintermann (2016), p. 26; BMAS (2017), p. 30.

[26] Cf. Daheim, Wintermann (2016), p. 15.

[27] Cf. BMAS (2017), for example, pp. 30-31, p. 36.

[28] Cf. Daheim, Wintermann (2016), p. 15.

[29] Cf. BMAS (2017), pp. 30 et seq.

certain soft skills, such as commitment, motivation or the capacity to learn new ideas, using those in order to strengthen relevant hard skills.

In the changed world of work and under new frame conditions of the employment market, many transferable skills are not only valued more than in the past, but often perceived to be even more relevant than certain hard skills. This is irrespective of the chosen career path. Hybrid competence profiles that combine entrepreneurial thinking and acting with creativity, social competences and technical expertise become the foundation for employability in ever more complex employment fields. So-called "meta-competences" enable individuals to adapt to permanent transition and navigate through changing business environments and volatile labour markets. This refers to competences that are relevant in different fields and needed when professions change quickly. It includes, for examples, the ability to produce output in unstructured working environments under conditions of changing work objectives and lacking traditional strategies and methods and procedures where individuals have to establish their own working structures.[30]

More specifically, a study conducted by the German Federal Ministry of Labour and Social Affairs (BMAS) (2017) points at the most required future skills and competences for academics and managers in 2030, namely information processing and problem solving (intellectual competence requirements), teaching and management and coordination (social-interactive competence requirements), working independently and teamwork (methodical competence requirements) and handling man-machine-interfaces (digital competence requirements)[31]. Moreover, change management, adaptability, effective self-organisation, learning capacity, entrepreneurial skills, the abilities of systematic thinking (that perceives tasks in the overall context), of interdisciplinary thinking, of transferring knowledge into practice and communication are all heavily demanded at the job market. Hence, employers search for a mix of intellectual, social and organisational skills that is based on profound expert knowledge.[32]

Other research work from Fondazione Ergo (2017) focuses on the comparison between the relevance of skills required today and their expected importance in 2025 from the perspective of the automotive sector. Table 4 provides a summary, while the skills with increasing importance are highlighted in boldface. Intriguingly, relational skills are expected to remain most important also in 2025, while distinct aspects of digital skills, technical skills, problem-solving skills (individually and in teams) and flexibility are among the top ten group of future transferable skills. As technical skills and working in teams are both part of the top ten group in 2017 and in 2025, the findings of Fondazione Ergo (2017) are broadly in line with the results of the BMAS (2017).

[30] Cf. Daheim, Wintermann (2016), p. 18.

[31] Cf. BMAS (2017), pp.36-37. The study uses scenario technique to estimate skills and competence requirements of academics and managers in 2030, based on a two-stage Delphi study with in-depth interviews conducted with 40 experts from science, administration, economy and politics. It analyses data from six different industries, namely industry and production, craftsmanship (focus on construction and electronics), banking and insurance, business services (focus on creative industry), public service and healthcare.

[32] Cf. BMAS (2017), pp. 36-37.

Rank 2017	Rank 2025	*Skill*
1	1	*Relational skills*
8	**2**	***Digital skills***
3	3	*Technical skills*
7	**4**	***Problem solving (individual)***
2	5	*Quality control skills*
5	6	*Working in teams*
-	**7**	***Programming skills***
-	**8**	***Flexibility***
-	**9**	***Designing user experience***
-	**10**	***Complex problem solving (groups, system)***

Table 4: Comparison between the perceived importance of skills in 2017 and 2025[33]

Yet, the skills that were among the ten most relevant in 2017, but that are not expected to be so in 2025, are resource management, physical skills (manual precision and ability), system and process analysis and training/teaching skills.

In the same study, the top ten skills that are perceived to be most developed in 2025 compared to 2017 are displayed in table 5. Hence, besides digital skills (in a narrower and broader sense), these are adaptability and the ability to change, autonomy, working in teams and the ability to lifelong learning.

Rank 2025	Skill
1	Using and interacting with computers, robots, smart machines
2	Adaptability and ability to change
3	Management and analysis ability of new production processes
4	Management of communication between machines
5	Big data analysis and subsequent decision making
6	Ability to process (big) data arising from machines and production processes
7	Autonomy
8	Working in teams
9	Lifelong learning ability
10	Ability to develop predictive models

Table 5: Comparison between most developed skills in 2025 compared to 2017[34]

Moving from future to present skills, the European University Association (EUA) (2015) presents a typical skills profile for PhD graduates required by the business sector that displays "a mix of cognitive, social and communication skills"[35]. Figure 22 provides an overview of the perceived importance of skills of doctoral holders at the time of their recruitment requested by employers.

[33] Cf. Fondazione Ergo (2017), p. 19, modified. The database is comprised of 38 interviews conducted with plant managers, human resources administrators and supply chain specialists in the automotive sector.
[34] Cf. Fondazione Ergo (2017), p. 20, modified.
[35] Borrell-Damian, Morais, Smith (2015), p. 50.

Figure 22: Average importance of skills required from doctorate holders at the time of recruitment[36]

Corporations typically search for a skills profile based on deep technical expertise, problem solving and analytical competences, for example, integrating ideas from various distinct sources. Social skills, for example, being a team player, are also regarded important. Leadership potential and entrepreneurial thinking were assessed as moderately relevant when recruiting PhD holders.[37] The EUA profile is broadly in line with current frameworks, such as the framework for professional development of researchers generated by Vitae.[38]

Drawing on the German study of Minks (2004) allows us to display the most required competences of highly qualified mechanical engineers five years after graduation in figure 23, which reconfirms the high importance of transferable skills.

[36] Cf. Borrell-Damian, Morais, Smith (2015), p. 50. The Likert scale in the figure ranges from 1 (low importance) to 5 (high importance). The project "Promoting Doctoral Education for Enhanced Career Opportunities" (DOC-CAREERS II) looks at a variety of collaborative models between universities and their business and other non-university partners in the framework of doctoral education. For research context and methodology, see pp. 10 et seq. Number of respondents: 10/14 (DOC-CAREERS II case studies - companies).

[37] Cf. Borrell-Damian, Morais, Smith (2015), p. 50.

[38] Cf. Vitae (2011); Borrell-Damian, Morais, Smith (2015), p. 50.

Figure 23: Most important competences in the profession of mechanical engineering (university degree), 5 years after exam[39]

It is apparent that the competences presented include a variety of social, organisational and methodical competences. Mostly, one aspect of sector-specific expertise, namely broad basic knowledge, plays an important role, while subject-specific knowledge and economic knowledge are of minor importance.[40] The same study shows for engineers in management positions amongst others the high importance of transdisciplinary thinking and cooperation skills with growing demand, especially within modern, globalised working cultures.[41]

However, some studies also reveal that the essential competences employers search for in many cases have not been sufficiently developed. According to Minks (2004), for example, one year after receiving their university degree, qualified engineers and computer scientists express competence deficits particularly in the ability to overtake responsibility, leadership competence, communication management, time and conflict management, assertiveness and negotiating skills.[42]

These findings are also broadly in alignment with the subsequent study results presented by the EUA (2015): while the participating employers perceived the technical and scientific skills and expertise of doctoral holders to be very good or good, they noticed weaknesses with regard to social skills, for examples, difficulties in working in teams, communication or organisational skills (besides low levels of knowledge about business environment or business processes.)[43] Here, universities are asked to overtake more responsibility in training such competences.

As previously indicated, a number of studies in Italy have been carried out in order to identify the most useful skills to be developed to prepare graduates for their careers. They focus particularly on M.Sc. and PhD graduates entering the private sector. Most of these studies investigate the transferable skills for M.Sc. and PhD graduates as a unique group, considering that similar types of these skills could fit both target groups.

[39] Cf. Minks (2004), p.34. The study is designed as longitudinal analysis of university graduates Die first survey is conducted approximately one year after graduation. The second survey takes place approximately five years after graduation. For further details, see p. 33. The data refers to graduates in 1997, 2nd survey.
[40] Cf. Minks (2004), p. 38. The data refers to graduates in 1993, 2nd survey.
[41] Cf. Minks (2004), p. 38. The data refers to graduates in 1993, 2nd survey.
[42] Cf. Minks (2004), pp. 36-37. The data refers to graduates in 2001, 1st survey.
[43] Cf. Borrell-Damian, Morais, Smith (2015), p. 52.

In 2017, Fondazione Emblema found that the soft skills most sought after by corporate employers are motivation, autonomy and versatility[44]: As candidates tend to underestimate the importance of interviews, universities could support them by trainings in interviewing and negotiation skills.

In addition, the Italian Chambers of Commerce (2017), assessed the demand in digital skills in Italian companies[45]. One third of the participating employers require the ability to manage and apply some or several 4.0 technologies. Most important are basic digital skills, which are required as a prerequisite in more than half of the incoming candidate profiles. Basic digital skills include the ability to manage visual and multimedia communication tools, to use mathematical and computer languages and to organise and evaluate qualitative and quantitative information.

Finally, Università Ca' Foscari Venezia (2017) concluded that the three most important skills demanded of a recent graduate for an internship and working position are teamwork, adaptability and flexibility and communication skills (both written and oral). According to companies, new graduates are entering the companies with a wealth of skills that are already valuable. Recruiters find in young candidates teamwork skills and remarkable adaptability. On the contrary, they are less endowed with empathy, tolerance, stress management or networking and problem-solving skills. 69% of the participating companies declared that the transferable skills of candidates are not properly addressed in CVs. [46]

To support early-career researchers (ECRs) to identify, assess and document the transferable skills and competences they have already obtained and they still need to acquire, the transferable skills matrix of Eurodoc (2018)[47] was designed. It comprises nine main competence categories that concentrate on research, teaching and supervision, career development, cognitive, digital, communication, interpersonal, enterprise and mobility for ECRs. The overall objective of the matrix is to increase awareness for the uptake and training in transferable skills among ECRs and higher education institutions (HEIs).

III.3 Competence profiles

Considering the needs of PhD candidates and the requirements of employers, has led to the identification of clear demands with regard to distinct career paths and fields of employment. Hence, during their studies, PhD students need to develop an extensive range of competences to be prepared for career options in- and outside academia. The competence requirements include both, **subject-specific** as well as **generic transferable competences**. The PhD candidates´ competence development thereby follows their **own interests and career aspirations**, the **needs of the labour market** and **current socio-political trends**, such as internationalisation, globalisation, digitalisation or sustainability.

To cover all required competence areas in transferable skills that need to be developed by PhD candidates and have been previously identified, the Centre for Scientific Continuing Education and Cooperation (ZEWK) of TUB has developed an overall competence model for SET PhD students and graduates, which is displayed in figure 24.

[44] Cf. Fondazione Emblema (2017). Sample: 300 persons responsible for personnel selection in micro, medium and large companies[44].
[45] Cf. Unioncamere (Italian Chambers of Commerce) (2017). Self-assessment test on digital demands made by over 2800 companies through the portal of the Chambers of Commerce: www.puntoimpresadigitale.camcom.it.
[46] Cf. Università Ca' Foscari Venezia (2017). Sample: 90 local and international small and medium-sized enterprises (SMEs).
[47] Cf. Eurodoc (2018).

While the model was initially inspired by the Research Development Framework (RDF) developed by Vitae[48], it then needed to be extended to accommodate all competence profiles (for example, of teaching professionals, managers or entrepreneurs) – and not only those of PhD candidates pursuing a researcher career. In a next step, it was drawn on the competence atlas of the University Association for the Qualification of Junior Researchers in Germany (UniWiND)[49] and on the results of the HIS graduate survey[50] on subject-specific and generic transferable competences of engineers and computer scientists to develop a comprehensive model. Thus, the following model comprises the competence demands for all identified career paths.

Figure 24: Overall competence model for SET PhD students and graduates, ©ZEWK/TUB[51]

In the centre of PhD students´ required competences are naturally **subject-specific competences** (hard skills). The faculties and respective PhD programmes carry responsibility for their development.

In addition, trans-sectoral and transferable or soft skills play an important role in PhD students´ competence sets. These include:

- generic work competence
- personal competence
- project management and research competence
- teaching skills

[48] Cf. Vitae (2011).
[49] Cf. Vurgun (2016).
[50] Cf. Minks (2004).
[51] Cf. ©ZEWK/TUB (2018).

- social and leadership competence and
- methodical competence.

While sufficient levels in all competence fields are required, priorities and strengthening of certain competences depend on individual career paths and aspired fields of employment. Those determine what competences are required. Each field of employment shows a specific competence profile that needs to be developed by individuals. Figure 25 shows four competence profiles according to different career paths.

Competence profile 1[52]: **RESEARCHER CAREER**	**Competence profile 2:** **CAREER AS TEACHING PROFESSIONAL**	**Competence profile 3:** **MANAGEMENT CAREER**	**Competence profile 4:** **CAREER AS ENTREPRENEUR**
Subject-specific competences			
Project and research skills: Third-party funding, resources management Concept and proposal development Project management methods Sciences marketing Sciences communication	**Teaching skills:** Didactical skills Educational skills Examiner competence Teaching/learning beliefs	**Social and leadership competence:** Cooperation and team working skills Communication and presentation skills Counselling and consultation skills Intercultural competence	**Entrepreneurial skills:** Creativity and innovative capability Third-party funding, resources management Research and project management skills Knowledge application to new problems and fields / transfer skills

Figure 25: Competence profiles according to fields of employment

As there are various combinations between fields of employment, PhD students and graduates often need to gain competences across different fields. Hence, their competence profiles grow beyond the requirements of one field and competence sets multiply.

[52] Please note that the numbers in the competence profiles do not indicate priorities.

IV. Conclusion

(including for the curriculum)

As the development of a curriculum aims at responding to the growing demands of the labour market in the best possible way, it is paramount to reflect the competences most required in the training offers of the curriculum. To achieve this, mindSET´s European Core Curriculum in Transferable Skills for SET Disciplines is based on a collective needs analysis. Its main objective was to identify training demands in transferable skills and competences relevant for SET PhD candidates across Europe. The results shed light on the questions what transferable skills are sought on the European labour market in general and on the employment markets for SET PhD candidates in particular, and which competences of doctoral candidates need to be strengthened in transferable skills trainings to secure their employability in diverse professional fields both in- and outside academia.

We have looked at the subject from two different perspectives: from the perspective of the European SET PhD candidates (**survey; primary data**) and from the perspective of the employers (**literature analysis; secondary data**).

When we analysed the questionnaire results, we first concentrated on the transferable skills and competences that are most sought after as seen from the perspective of European SET doctoral candidates. **The questionnaire data clearly shows a high demand for all eight competence areas covered in the survey.** Yet, there are certain foci**.**[53]

According to the survey findings, more than 50% of the responding SET PhD candidates require each of the eight competence areas listed[54] and among them, every fifth doctoral candidate states that these competence areas are needed very strongly.[55] Intriguingly, competences in the field of **"Acquiring third party funds and projects"** are in particularly high demand. More than three quarters of the survey participants indicate that these competences are sought after and more than one third (38,5%) claims them to be much sought after. In addition, competences in the area of **"Cooperation, communication and presentation"** are considered almost as needed. Nearly three quarters of the participating SET PhD candidates consent that these competences are required and more than one fourth (28,5%) state that they are strongly required. Equally as exciting are the results for competences in the areas of **„Leadership and management"** (demanded by almost two thirds of all respondents and to be highly demanded by nearly every third respondent) and **"Time and project management"** (required by almost two thirds of all survey participants and strongly required by more than every fourth participant). Competences in the field of **"Publication, promotion and transfer of research results"** are only slightly behind (also sought after by nearly two thirds of all questionnaire respondents and strongly thought after by every fifth respondent). Even competence in the area of **entrepreneurial thinking**, which is deemed to be least required, can unite more than 50% of the survey participants.

As every competence area consists of several **individual transferable skills and competences**, it is also necessary to address this level to get to a more comprehensive picture[56]. **Generally, it can be noted that all individual transferable skills and competences provided in the questionnaire are**

[53] For a detailed overview of the values see table 1.

[54] The competence areas covered in the survey are acquiring third party funds and projects, time and project management, teaching methods, cooperation, communication and presentation, entrepreneurial thinking, leadership and management, publication, promotion and transfer of research results and research ethics and good scientific practice.

[55] The percentages with regard to the answer "I fully agree" to the question Q1 "I would be interested in attaining a training course on the following subject…" are the following: 38,5% referring to Acquiring third party funds and projects, 29,2% to Leadership and management, 28,5% to Cooperation, communication and presentation, 26,4% to Time and project management, 21,8% to Teaching methods, 21,3% to Research ethics and good scientific practice, 19,9% to Entrepreneurial Thinking and 19,6% to Publication, promotion and transfer of research results.

[56] For a detailed overview of the values see table 2.

required by SET PhD candidates who participated in the mindSET European Transferable Skills Training Demands Survey.

Looking at the top group of individual transferable skills that are in particularly high demand, it shall be confirmed that the results referring to the **individual transferable skills and competences** are in line with the previous findings about the most essential **competence areas** (see table 1). The ten most required individual transferable skills are: Effective academic and scientific writing (rank 1), drafting a project proposal (2), Effective and professional communication and presentation guidelines (3), Scientific communication: communication to an academic audience (4), Effective building of networks, collaboration, teams and alliances (5), Professional concept development (6), Time management, setting priorities and milestones, organising a researcher´s day (7), Creating a project budget (8), Popular science: communicating research to a non-specialist audience (9) and Interviewing and Negotiation Skills (10).

While competences in the areas of "Acquiring third party funds and projects" and "Cooperation, communication and presentation" were required most by SET PhD survey participants (see table 1), this picture is also reflected on the level of individual transferable skills and competences: Among the ten transferable skills and competences that are most sought after three individual transferable skills can be found that belong to "Acquiring third party funds and projects" (ranks 2,6 and 8). In addition, also three individual transferable skills and competences out of ten are attributed to "Cooperation, communication and presentation" (rank 1, 3 and 5). The findings confirm that transferable skills in these two competence areas are most sought after by SET PhD candidates. Two individual competences out of the top group belong to the competence area of "Publication, promotion and transfer of research results" (rank 4 and 9) and one each is attributed to the field of "Time and project management" (rank 7) and "Leadership and Management" (rank 10).

In contrast to the overall high demand for transferable skills, there are hardly any transferable skills that are not required from the point of view of the SET PhD candidates. Only five transferable skills were indicated as little or not required by at least a quarter and more of the PhD candidates surveyed. These are:

- Human Resources Management (37%)
- Assessment and grading (28%)
- Developing business ideas, business plans and business models (28%)
- Founding a start-up (motives, risks, concepts, practical support (27%)
- Research with dual-use implications (25%)[57]

These individual transferable skills less sought after by SET doctoral candidates confirm the demands reflected in their attributed competence areas "Teaching methods" (Assessment and grading) (see table 1: rank 6), "Research ethics and good scientific practice" (research with dual-use implications) (rank 7) and "Entrepreneurial thinking" (Founding a start-up (motives, risks, concepts, practical support), developing business ideas, business plans and business models and human resource management) (rank 8). However, Human Resources Management does not fit the picture as it is critical for success – either in management positions or when starting one´s own venture. It can be assumed that the low demand indicates that personnel responsibility in management positions or in start ups is underestimated by the target group.

[57] Total percentage of responses "I don´t agree at all" and "I rather don´t agree" to Q1 "I would be interested in attaining a training course on the following subject…", mindSET questionnaire on qualification needs amongst European PhD candidates, N=437; mindSET European Transferable Skills Trainings Demands Survey.

While the survey´s main objective was to identify the training needs in transferable skills and competences of SET PhD candidates across Europe, the **secondary analysis** was intended to find out more about the skills and competence requirements of employers in- and outside academia. In adding their perspective, possible blind spots ought to be uncovered.

Even though existing research uses different approaches for skills demands analysis[58], various studies agree that, today, transferable skills play a major role in businesses, the industry and public and private sectors,[59] irrespective of the occupational level or career path[60]. Employers emphasise that the importance of transferable skills has grown considerably during the last decades and is most likely to grow further in the future.[61] In general, employers ask for extensive, but still very diverse competences. This is due to the fact that those skills demands derive largely from changes in the world of work. The latter has been shaped by megatrends such as rapid technological change, digitalisation and internationalisation[62]. All of these factors have led to a significant shift and extension of competence requirements.[63]

European studies address current and future skills demands among employers in distinct labour markets within and beyond academia and for multiple career paths. Some of the researchers have developed transferable skills profiles of SET PhD graduates for specific industries. The European University Association (EUA) (2015), for example, presents a typical current skills profile for PhD graduates required by the business sector that displays "a mix of cognitive, social and communication skills"[64]. Corporations typically search for a skills profile based on extensive technical expertise, problem solving and analytical competences, such as integrating ideas from distinct sources. Social skills, like being a team player, are also regarded as important.[65]

Several studies also focus on required competences that have not been fully developed during PhD and master studies. According to the study of EUA (2015), employers noticed competence deficits of PhD holders particularly with regard to social skills, for examples, difficulties in working in teams, communication or organisational skills.[66] Minks (2004) discovered that qualified engineers and computer scientists lack the ability to overtake responsibility, leadership competence, communication management, time and conflict management, assertiveness and negotiating skills.[67] Finally, Università Ca' Foscari Venezia (2017) concluded that young candidates are less endowed with empathy,

[58] Existing studies address current and future skills demands in distinct employment markets and for multiple career paths.

[59] Cf. e.g. Università Ca' Foscari Venezia (2017). Sample: 90 local and international small and medium-sized enterprises (SMEs). Target group: M.Sc. and PhD graduates entering the private sector. Results: 62% of the participating companies declared that the selection of candidates was influenced to a great extent by the availability of transferable competences, especially at junior level.

[60] Career paths within universities include scientific, management or other academic careers, for example, as professor, research associate or teaching staff for special duties. Other options outside universities are, for example, in private/non-university research institutes or universities of applied sciences, following a scientific, specialist or management career in an expert or in a leadership position. Finally, doctoral candidates will find employment in industry and follow a specialist or management career in an expert or leadership position or they will start their own business and be self-employed as an entrepreneur. Hence, the different fields of employment for SET PhD students and graduates are a career as researcher, teaching professional, manager or entrepreneur, often supplementing each other within various combinations.

[61] Cf. BMAS (2017), pp. 36-37; Università Ca' Foscari Venezia (2017)

[62] Cf. Daheim, Wintermann (2016), p. 26; BMAS (2017), p. 30.

[63] Cf. BMAS (2017), pp. 30 et seq.

[64] Borrell-Damian, Morais, Smith (2015), p. 50; see also Vitae (2011). The study presents the perceived importance of skills of doctoral holders at the time of their recruitment requested by employers in the business sector.

[65] Cf. Borrell-Damian, Morais, Smith (2015), p. 50.

[66] Cf. Borrell-Damian, Morais, Smith (2015), p. 52.

[67] Cf. Minks (2004), pp. 36-37. The data refers to graduates in 2001, 1st survey. The deficits were expressed by qualified engineers and computer scientistsone year after receiving their university degree.

tolerance, stress management or networking and problem-solving skills.[68] Here, universities are asked to overtake more responsibility in training such competences.

It is advisable to focus on those transferable skills and competences that deserve special attention. The following list provides an overview of such skills and competences whose relevance has been repeatedly emphasised in various studies by employers within and beyond the university. Hence, the transferable skills and competences that are most thought after by employers are:

- (complex) **problem-solving** (in teams and individually)[69] and **analytical skills**[70]
- **adaptability, ability to change and flexibility**[71]
- **relational and social skills,** (such as) **being a team player or working in teams**[72]
- **digital skills** (in a narrower and broader sense)[73]
- **autonomy, independent working or effective self-organisation**[74]
- **communication skills**[75] and
- **trans-** and **interdisciplinary thinking**[76]**.**

In addition, the following transferable skills and competences have also been addressed:

- **leadership potential** (motivation and commitment)[77] and
- **negotiation skills.**[78]

Other studies analyse future trends. These show that some transferable skills and competences are just as important in the future, while others are set to become even more important. Fondazione Ergo (2017), for example, focuses on the comparison between the relevant skills required in 2017 and their expected importance in 2025 from the perspective of the automotive sector. Intriguingly, relational skills were ranked first in 2017 and are expected to remain most important in 2025. In addition, a growing importance is attributed to distinct aspects of digital skills, technical skills, problem-solving skills (individually and in teams) and flexibility, which are among the top ten group of future transferable skills in 2025. The same study highlights ten very important skills that are perceived as being most developed in 2025 compared to 2017. These are digital skills (in a narrower and broader sense), adaptability and the ability to change, autonomy, working in teams and the ability to lifelong learning, which will become even more important.

Research conducted by the German Federal Ministry of Labour and Social Affairs (BMAS) (2017) indicates the most required future skills and competences of academics and managers in 2030. These are information processing and problem solving (intellectual competence requirements), teaching and management and coordination (social-interactive competence requirements), working independently and teamwork (methodical competence requirements) and handling man-machine-

[68] Cf. Università Ca' Foscari Venezia (2017). Sample: 90 local and international small and medium-sized enterprises (SMEs).
[69] Cf. BMAS (2017); Università Ca' Foscari Venezia (2017); Fondazione Ergo (2017); Borrell-Damian, Morais, Smith (2015); Minks (2004).
[70] Cf. Fondazione Ergo (2017), Borrell-Damian, Morais, Smith (2015); Minks (2004).
[71] Cf. BMAS (2017); Daheim, Wintermann (2016); Fondazione Emblema (2017); Fondazione Ergo (2017); Università Ca' Foscari Venezia (2017).
[72] Cf. BMAS (2017), Fondazione Ergo (2017), Università Ca' Foscari Venezia (2017), Borrell-Damian, Morais, Smith (2015).
[73] Cf. Eurodoc (2018); BMAS (2017); Fondazione Ergo (2017); Italian Chambers of Commerce (2017); Daheim, Wintermann (2016).
[74] Cf. BMAS (2017); Fondazione Ergo (2017); Fondazione Emblema (2017); Daheim Wintermann (2016); Minks (2004).
[75] Cf. Università Ca' Foscari Venezia (2017), Fondazione Ergo (2017), Borrell-Damian, Morais, Smith (2015), Minks (2004).
[76] Cf. Borrell-Damian Morais, Smith (2015), BMAS (2017); Minks (2004).
[77] Cf. Minks (2004); Borrell-Damian, Morais, Smith (2015); Fondazione Emblema (2017);
[78] CF. Fondazione Emblema (2017); Eurodoc (2018).

interfaces (digital competence requirements). Moreover, change management, adaptability, effective self-organisation, learning capacity, entrepreneurial skills, the abilities of systematic thinking (that perceives tasks in the overall context), of interdisciplinary thinking, of transferring knowledge into practice and communication are all heavily demanded at the job market. Hence, future transferable skills profile required by employers includes a mix of intellectual, social and organisational skills that is based on profound expert knowledge.[79]

If we compare the key findings from mindSET´s primary and secondary analysis, it is interesting to see that there are overlaps. The literature analysis revealed transferable skills that are required by employers and that are also sought after by SET PhD candidates. This applies both to competence areas and individual transferable skills and competences. Examples for such competence areas that are mutually required are "Cooperation, communication and presentation" and "Leadership and management", while examples for individual transferable skills and competences are (self-)management, trans- and interdisciplinary thinking or working in and building teams.

In addition, the results of the secondary analysis provided valuable hints for designing the European Core Curriculum in Transferable Skills because they complemented the perspective of the survey and sharpened the focus of the needs analysis at the same time. While, for example, analytical skills, flexibility or digital skills had been integrated in the potential course offers and had, therefore, been addressed implicitly by the items of the questionnaire, it has now become evident that all transferable skills listed above ought to play a major role in the improvement of transferable skills trainings in doctoral education. These findings have been taken into account when developing the training opportunities further.

The main objective of mindSET´s collective needs analysis was to answer the question which competences of doctoral candidates need to be further developed in skills trainings to secure their employability in diverse professional fields both in- and outside academia. In conclusion, based on the results of a quantitative survey and of the analysis of the available studies, the key findings presented us with a comprehensive picture which competences in transferable doctoral skills trainings are perceived to be particularly important and are worth being strongly developed among SET PhD candidates. These insights were implemented in mindSET´s European Core Curriculum in Transferable Skills for SET disciplines. As both the training demands of doctoral candidates and the skills demands of employers have been fully taken into account, mindSET´s doctoral skills trainings can now prepare SET PhD candidates in the best possible way for different employment markets and various career paths.

[79] Cf. BMAS (2017), pp. 36-37.

Annex

EvaSys	Erasmus+ project 'Training the MindSET'	Electric Paper
Erasmus+ Training the MindSET	Petra Nikol	Co-funded by the Erasmus+ Programme of the European Union

Bitte so markieren: ☐ ☒ ☐ ☐ ☐ Bitte verwenden Sie einen Kugelschreiber oder nicht zu starken Filzstift. Dieser Fragebogen wird maschinell erfasst.
Korrektur: ☐ ■ ☐ ☒ ☐ Bitte beachten Sie im Interesse einer optimalen Datenerfassung die links gegebenen Hinweise beim Ausfüllen.

Co-funded by the Erasmus+ Programme of the European Union

Dear PhD student at TU Berlin,

TU Berlin participates in the Erasmus+ project "Training the MindSET" where we aim to develop a syllabus for transferable skills for PhDs in science, engineering and technology (SET) disciplines. As part of this project we are mapping the needs and interests of transferable skills trainings among our PhD students.

We hereby invite you to respond to a short questionnaire in order to get to know better your interests in an academic training in transferable skills. The information will help us develop a relevant and attractive training program and to provide tailored courses. It takes less than 10 minutes to complete the multiple choice form. All information given is handled anonymously.

The survey is conducted by Technische Universität Berlin (TUB). If you have questions to this survey, please contact Petra Nikol (petra.nikol@tu-berlin.de).

Thank you for your participation!

I would be interested in attending a training course on the following topic...

1. Acquiring third-party funds and projects						
1.1 Funding and research landscape (funding lines and programs; funding opportunities of key research and funding organizations etc.)	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
1.2 Drafting a project proposal	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
1.3 Creating a project budget	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
1.4 Professional concept development	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
2. Teaching methods						
2.1 Planning and designing teaching and learning processes (didactic principles, how to plan and structure lectures)	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
2.2 Project-based teaching and learning	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
2.3 Innovative teaching methods (digital media, blended learning, flipped classroom; activating teaching)	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
2.4 Teaching science, engineering and technology (SET)-classes (specifics, requirements, methods)	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
2.5 Assessment and grading	I don't agree at all	☐	☐	☐	☐	☐ I fully agree

F15526U0P1PL0V0 14.01.2019, Seite 1/3

EvaSys	Erasmus+ project "Training the MindSET"	Electric Paper

I would be interested in attending a training course on the following topic…

3. Time and project management						
3,1 Time management, setting priorities and milestones, organizing a researcher´s day	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
3,2 Project management fundamentals	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
3,3 Knowledge management in research projects, personal knowledge management	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
3,4 Delegating tasks, effective meeting organization, verification and execution of task delegation	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
3,5 Agile project communication management	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
3,6 Quality management and project evaluation	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
4. Cooperation, communication and presentation						
4,1 Effective and professional communication and presentation guidelines	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
4,2 Effective academic and scientific writing	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
4,3 Effective building of networks, collaboration, teams and alliances	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
4,4 Conflict management, group dynamics	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
4,5 Interdisciplinary and transdisciplinary research	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
5. Entrepreneurial thinking						
5,1 Founding a start-up (motives, risks, concepts, practical support)	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
5,2 Developing business ideas, business plans and business models	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
5,3 Human Resources Management	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
5,4 Funding and finances	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
5,5 Research-based innovation	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
5,6 Industrial dynamics of innovation; innovation strategy formulation and implementation (incl. creativity techniques); innovation protection	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
6. Publication, promotion and transfer of research results						
6,1 Intellectual property rights	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
6,2 Project marketing and disseminating research	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
6,3 Scientific communication: communication to an academic audience	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
6,4 Popular science: communicating research to a non-specialist audience	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
6,5 Scientific and technology transfer (third-party projects, patents, industrial cooperation, start-ups)	I don't agree at all	☐	☐	☐	☐	☐ I fully agree

EvaSys	Erasmus+ project "Training the MindSET"	Electric Paper

I would be interested in attending a training course on the following topic...

7. Leadership and management						
7.1 Leadership styles	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
7.2 Fundamentals of management: planning, organizing, directing and controlling	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
7.3 Interviewing and negotiation skills	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
7.4 Relationship management: coaching, guidance, motivation, team and management development; conflict management	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
8. Research ethics and good scientific practice						
8.1 Ethics in conducting research: academic integrity incl. (self) plagiarism, research values, (co-)authorship	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
8.2 Research data and result bias, manipulation and fabrication	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
8.3 Social impact of technological research	I don't agree at all	☐	☐	☐	☐	☐ I fully agree
8.4 Research with dual-use implications	I don't agree at all	☐	☐	☐	☐	☐ I fully agree

Are there any further topics you wish either training or coaching for?

Thank you for your participation!

Co-funded by the Erasmus+ Programme of the European Union

V. Literature list

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